ASSESSING BUILDING CONTRACTOR'S CONTRACT RISKS: THE CASE OF GRADE ONE TO GRADE THREE CONTRACTORS

By

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Declaration

I hereby declare that this thesis entitled "**Assessing Building Contractor's Contract Risks: The Case of Grade One to Grade Three Contractors"** is composed by myself, with the guidance of my advisor, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted, in whole or in part, for any other degree or professional qualification.

Name: **Zelalem Berhanu** _____ **May- 2018**

Certification

This is to certify that the thesis prepared by **Mr. Zelalem Berhanu** entitled "**Assessing Building Contractor's Contract Risks: The Case of Grade One to Grade Three Contractors"** and submitted for the partial fulfillment of the requirements for the Degree of Master of Science complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Dedication

This study is dedicated to my late mom, Kebebush, who gave me faith and unconditional love. May her soul rest in peace. I also dedicate it to my lovely wife, Betty, for her patience, understanding, and unlimited support.

ABSTRACT

Construction projects are subjected to several risks driven from multiple risk factors. For example, projects are often delivered by several parties (stakeholders) under different circumstances which by itself induces risk on each other. Among the various stakeholders, the contractor has been identified to be the party that carries the highest number of risks, including many which originate from parties other than him/herself. In this regard the contractor is exposed to contractual risks which occur as a function of contract provision and clauses. This research study seeks to identify and evaluate potential risk factors contractors are exposed to while executing a contract. Using a questionnaire based survey research methodology; the study identifies major risks and determines their likelihood of occurrence as well as their impact. Further to this, the study also investigates the allocation of each identified risk factors from contractors perspective, and the risk management approach as perceived by local contractors. Based on their likely of occurrence, the research identified inadequacy of time or finance, late supply of information/ design data/ drawing, defective design, financial constraint, delay in payment, and inflation risk factors as the most common contract risks in the local construction industry. Key risk factors are also identified based on the level of impact, inadequacy of time or finance, exchange rate, delay in settling claim on overall performance, time and cost performance. Defective design, financial constraints, inflation on overall, time, cost and quality performance. Similarly, delay in payment and mistakes in document on time, cost, and quality performance, and time and cost performance respectively. In addition, the result shows that the allocation of risk to the parties to the contract is different to what is recommended in the literature. Regarding management practice in the industry, the study shows that contractors in the study do not conduct formal risk identification and analysis in their project management activities. The research concluded that to solve identified risks, as most of identified risk factors cannot be controlled or managed by grade one to three contractors. In addition, contractors working in this contract is expected to accept some of the risks. It is important to put additional conditions within the construction contract which is designed to solve the problem. Risk allocation should be done based on accepted principles. The risk management approach (identification, analysis, and response) being employed by the contractor is below average or not up to the accepted practice.

Key words: Risk, Risk management, Contract risk, Construction contract, Contractor.

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List of Abbreviations

AACRA	Addis Ababa City Road Authority
AB	General Conditions of Contract for Building, Civil Engineering, and Installation Works (Allmänna Bestämmelser) (Sweden)
ABT	General Conditions of Contract for Building, Civil Engineering, and Installation Work Performed on Package Deal Bases (Allmänna Bestämmelser för Totalentreprenader) (Sweden)
BaTCoDA	Building and Transport Construction Design Authority
BOT	Build Operate Transfer
CM	Construction Management
COTM	Construction Technology and Management
DB	Design Build
DBB	Design Bid Build
DBFO	Design Build Finance Operate
E.C.	Ethiopian Calendar
EMV	Expected Monitoring Value
ERA	Ethiopian Road Authority
MoFED	Ministry of Finance and Economic Development
MoWUD	Ministry of Works and Urban Development
MUDHo	Ministry of Urban Development and Housing
NCB	National Competitive Bidding
OPMPI	Office of Project Management Process Improvement
PDRI	Project Definition Rating Index
PI	Probability and Impact
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PPPAA	Public Procurement and Property Administration Agency
PRAM	Program Risk Analysis and Management
RAMP	Risk Analysis and Management for Project
RBS	Risk Breakdown Structures

RMP	Risk Management Process
RMS	Risk Management Standards
ROW	Right of Way
SBD	Standard Bidding Document
SME	Subject Matter Experts
SWOT	Strength Weakness Opportunity and Treats
UK	United Kingdom
UNESCO	United Nations Educational Scientific and Cultural Organization
WAS	Weighted Average Score
WBS	Work Breakdown Structure
WSDOT	Washington State Department of Transport

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

As stated by Ayalew *et al.*(2016), the construction industry in Ethiopia, like many other developing countries, faces many challenges in its practice. Some of these challenges are project overruns, poor quality, inappropriate procurement systems, and a failure to cope with project requirements and the inability to adopt best practices, Zewdu and Aregaw (2015), Mengesha (2004) and Assefa (2008) cited by Ayalew *et al.*(2016). In addition based on Ayalew *et al.*(2016) paper the Ethiopian construction industry is characterized as poor in meeting project requirements such as cost, time and quality. As noted by the writers *(ibid)*, the management challenges of the industry are time, cost, risk, safety, and resource management. Further to this, these writers found out in their assessment that the overall performance of the Ethiopian construction industry is more likely on the side of the " lower level".

One of the areas the Ethiopian construction industry is identified to be performing poorly is construction project risks management. To this end, Table 1.1 provides previous studies done on risk management in Ethiopia by different researchers. from the tabulated research works, it can be observed that the risk management practice in Ethiopian construction industry is low which is in agreement with Ayalew *et al.*(2016).

However, the country has been implementing significant number of programs and projects like housing development program and university capacity building projects. The number of contractors joining the Ethiopian construction industry is increasing thereby making a systematic approach towards risks management as one of the area the country ought to improve in order to improve the sector's overall performances. In this regard, it is observed in the Table 1.1 and other papers by Desta (2015) and Asaminew (2013) even the few studies conducted in risks management in Ethiopian context focus on Ethiopian road construction projects. Conversely, there are few studies on building construction project specially on the building contractor's risk source associated with the standard bidding document for the procurement of works in Ethiopia.

Table 1.1 Previous studies done on risk management in Ethiopia and there key findings

No	Author	Title	Key Findings
1	**Tsegaye 2009**	**Design risk management in Ethiopia federal road projects.**	➢ Design risks particularly design errors and omissions contribute to time and cost overruns of projects. ➢ Road construction risks are not managed with formal risk management system which involves risk management planning, identifications, assessment, response planning, and monitoring. ➢ Design review, and design and construction supervision by consultants are the mechanisms currently in place to mitigate design risks. ➢ Design risks are among the major risks in road construction projects, and has an impact on cost, time and quality of projects.
2	**Yilma 2014**	**The practice of construction risk management through insurance in the Ethiopian federal road projects.**	➢ On knowledge of risk management contractors and consultants understand risk management through reading and practice than the client and insurance companies. ➢ Majority of participants in the road construction industry use "past experience/Analysis of prior projects" in the identification of risk factors in the road construction industry. ➢ Client (ERA) mainly use opinion of external consultant (design and

			supervision consultant) as no one method for risk identification. On the other hand consultant and contractor use site visit and past experience / analysis of prior projects as the first two top risk identification methods. ➢ The contracting parties mainly provide insurance coverage to road projects to meet the demand of the client rather than to avoid possible risks. ➢ No proper risk allocation practice among contracting parties in the Federal road construction project due to lack of knowledge in the importance of proper risk management of construction projects. ➢ Contractors mainly conduct risk analysis at the time of tendering. Most of contracting groups just add a percentage to budget / cost to cope up with uncertainties rather than implementing mathematical tools to quantify risks.
3	**Tegabu 2015**	**Right of way (ROW) risk management of road construction project in urban areas: A case study of Addis Ababa.**	➢ The major problems for non achieving project objectives of Addis Ababa City Roads Authority (AACRA) are the slow clearance of obstructions from the ROW limit, due to lack of alignment among the stakeholders, there is no formal risk management entertained by any of the parties.

			➢ Out of the major factors selected, ROW related risks are found to be with high probability of occurrence and high impact on time and cost on urban road projects. ➢ The concept of the Project Definition Rating Index (PDRI) modified to AACRA, its correlation with project success and its use as a risk management tool provide wide ranging benefits when utilized at the recommended process points. ➢ Due to lack of skill, awareness and knowledge no financial compensation was entertained so far to the local contractors, the client was losing extra cost due to payment for the supervision consultants and price escalation for some selected work items as a result the domestic contractors are less interested in participating in AACRA projects.
4	**Mesfin 2014**	**Construction contract risk management practice in Ethiopia building construction project.**	➢ 97% of parties involved in Ethiopian building construction are aware of the concept of risk management through study and training but only 15.4% of the parties are confident enough to implement their knowledge of risk management principle &technique to make their projects successful. ➢ 84.6% of parties involved in Ethiopian building construction projects don't use risk management techniques in their projects because of lack

			of awareness about their significance and some don't use them fearing they need to hire additional staff and acquire more resources. ➢ The parties involved in the building construction project, design bid build (DBB) contract have least level of risk while design build (DB) and force account involve high risk. ➢ The parties involved in the building construction project, financial difficulty and poor contract management have high level of impact and occurrence on project objectives. ➢ The methods and techniques mostly used in the building project to identify, asses, allocate and mitigate the risks are individual judgment and past experience.

Further to this, risk has significant impact on a performance of any construction project. That is its uncertainty that significantly affects project objectives. As stated by Ayalew *et al*. (2016) the performance of construction projects against what was planned can be measured and evaluated using a large number of performance indicators that could be related to various dimensions (groups) such as time, cost, quality, client satisfaction, business performance, health and safety. However, cost, time and quality are the three basic and leading performance indicators in construction projects because of their dependence on each other. In this regard the Ethiopian construction industry is characterized as poor in meeting these three project requirement.

1.2 STATEMENT OF PROBLEM

Contractual risks have the greatest effect on projects because the actions of parties to contract in responding to duties and obligations dictate the speed of the project execution and eventual completion Nathaniel (2012). Nevertheless, according to Mesfin (2014) 84.6% of parties involved in Ethiopian building construction projects don't use risk management techniques in their projects because of lack of awareness about their significance and some don't use them fearing they need to hire additional staff and acquire more resources. Related with the above study, according to Ayalew *et al.*(2016), one of the most challenging issue for professionals in managing their day to day activity in terms of project management practice in Ethiopian construction industry is risk.

Risk and uncertainty occurs in every construction project. The size of the project being small or large, factors such as location, complexity, build ability, and type of building can all contribute to risk. According to Banaitiene and Banaitis (2012) risk and uncertainties, involved in construction projects, can cause cost overrun, schedule delay, and lack of quality during the progression of the projects to ends.

To this, it is argued that the application of sound project risk management practice provides construction project stakeholders with the means to meet their objectives. Lack of sound project risk management by owner or contractor on project leads to construction delay, extra cost for parties. In addition to the problem that occur during construction, poor project risk management can also result in completed facility that fails to meet the specified quality, suitability of material, fails to produce the intended products, and cannot be operated for its intended life which usually results in claim from contractors and counter claim from owner and vice versa King (2017).

Therefore, the risk analysis and management to be a major features of the project management of construction projects in an attempt to deal effectively with uncertainty and unexpected events to achieve project success. In addition it helps the key project participants client, contractor, and suppliers to meet their commitments and minimize negative impact on construction project performance in relating to cost, time, and quality objectives.

Further to these, risk management in construction project is to be a large extent governed by the choice of the contractual forms and what is stated in the related contractual documents Osipova and Apleberger (2007). In Ethiopia, DBB project delivery system is commonly applied. In this type of delivery system the most common means of selecting the general contractor is by the least evaluated bidder techniques.

In this regard, several competing contractors estimate the project based upon the contract documents and the builder with lowest price that satisfied the qualification criteria gets the contract. According to Jackson (2004) DBB delivery method is a very linear in nature and contractor does not have any input regarding the design of the project. The contractor is only responsible for carrying out the works spelled out in the plans and specifications and will utilize the various construction management functions to accomplish his task.

However, even though, risk associated with design stage are mostly related to clients, designers, and government body. Some risks in design stage also extend their occurrence and influence to the tendering and construction stage. Such as tight project schedule, insufficient site information, insufficient project schedule, high performance/ quality information, lack of coordination between project participants, excessive approval procedures in administrative government department, bureaucracy of government and price inflation of construction materials have an influence on project objectives Zou *et al.* (2007).

On the DBB contract, at the time of bidding, the contractor is expected to understand all the information in the short period of time and to provide the client with unintelligent but profitable bid. Low bid award is extremely competitive by their very nature, with this competition return bids having extremely tight margins of error or none at all, which is difficult. If the contractor properly considers the contract, specification, drawing and all the necessary information from his past experience, and given data, will significantly increases the risk of the contractor during bidding , construction and end of the project.

Therefore, it is necessary to consider the building contractors risk source associated with the standard bidding document , and this study intended to identify common contract provisions that form as risks to contractor. In addition, the study tries to briefly explore in literature review the risk management process, risk classification, and project delivery methods and others with a view to enlighten on building contractors risk sources within the Standard Bidding Document (SBD) for the procurement of works in Ethiopia, issued by Public Procurement and Property Administration Agency (PPPAA) National Competitive Bidding NCB (2011).

1.3 AIMS AND OBJECTIVES

This study aims, to explore common contract provisions that form as risks to contractor and to explore risks that building contractors are exposed to the SBD for the procurement of works, issued by PPPAA NCB (2011).

In order to achieve the aim of this research the following objectives are listed:

- To identify and evaluate potential risk factors contractors are exposed to while executing a contract;
- To determine the likelihood of occurrence as well as impact of these risks;
- To investigate the allocation of each identified risk factors from contractor's perspective;
- To identify and evaluate their risk management approach (preventive and mitigation measures) as perceived by local contractor in the current period.

1.4 RESEARCH QUESTIONS

From the above listed objectives the following questions are raised in relation to the SBD from the procurement of works issued by PPPAA (2011) to answer the objectives of the research:

- What kinds of contractual risks affect performance of building construction projects administered under the PPPAA conditions of contract?
- How are building construction risks managed by Ethiopian building contractors?
- Who are the sources of those potential risks in building construction projects from contractor's perspective?
- How can the negative impacts of these risks be mitigated?

1.5 SCOPE AND LIMITATION OF THE STUDY

As discussed in the subsequent chapter, there are a number of standard forms of construction contracts that have been formulated and put in use in Ethiopian construction industry. But the SBD for the Procurement of Works, issued by PPPAA (2011) form of contract is selected for this study because it is widely in use in the current stage. In addition to this, the study is intended to explore common contract provisions that form as risks to contractor. Hence, this study focuses to risks that building contractors are exposed; to evaluate those identified, classified risk factors from its own perspective to develop strategies, to meet project objectives, and understand risk management process. As a result; only risks within the SBD for the Procurement of Works, issued by PPPAA (2011) form of contract will be considered and not any other form of contract. There are of course other stakeholders involved within the PPPAA based contract. However, due to time limitations to address all stakeholders risk source; this study is limited to the building contractor's risk sources associated with this SBD and those contractors who have at least one PPPAA based project. In line with this, only grade one to three local contractors are considered in this study. Although, this research is done in Addis Ababa, the result and conclusions can be applied to the construction industry in the other areas of the country because of the similarity of the rules and regulations.

1.6 SIGNIFICANCE OF THE STUDY

The study finding may help contractors, professionals, and parties involved in the building construction project; and based on standards and other countries practice mentioned on the reviewed literature it may help contractors to improve their risk management approaches to achieve project objectives and understand the risk management process. In addition to this it gives awareness to the contractors on their obligations and the risk associated with their contract. Furthermore; the identified and classified potential risk factors within the SBD will enable contractors to consider the roles of project stakeholders when developing project risk management plan.

1.7 ORGANIZATION OF THE STUDY

This thesis contains five chapters as described below;

Chapter one is an introductory part containing discussions on background, research problems, aim and objective of the research, significance of the research, scope and limitation of the research and organization or layout of the research.

Chapter Two presents literature review with general descriptions by different researchers on concept of risk, risk on construction project, procurement method, contract and risk, project risk management process, tools and techniques, risk classification, project delivery methods and others.

Chapter Three discusses about research design and methodology. This section reflects the underlying assumptions about the research methodology employed and discusses the research methods used. The section address issues like, research design, research approach, research strategies, research method choice, time horizon, sampling, design of the questionnaire, reliability of the questionnaire, data collection and analysis techniques.

Chapter Four presents the results of the data obtained from the questionnaire survey and discussion of the research findings. Consequently, questionnaires response rate, general information of the respondent, potential risk factors, the probability of occurrence and impact of the risk factors from contractors perspective, risk management approach, and risk management practice promotion are addressed subsequently.

Chapter Five Contains conclusions and recommendations based on what is discussed on the previous chapters including the research questions, objectives and the findings of the research.

2. LITRATURE REVIEW

2.1 INTRODUCTION

As stated in previous chapter risk management is one of the knowledge areas of project management. The application of sound project management practice and effective risk management techniques to manage risks associated with various construction activities has become very important for the successful delivery of a project. Therefore, risk management process is a basic principle of understanding and managing risk in a construction project. It consists of different steps. All steps in the process should be included when dealing with risks in order to efficiently implement the process in the project. In addition, risk management in construction project is to be a large extent governed by the choice of the contractual forms and what is stated in the related contractual documents. Furthermore, how risks are shared among the actors in a construction project is to a large extent governed by the choice of project delivery option. There are advantages and disadvantages to each type of project delivery methods. It's the owners job to select the best project delivery method relative to the requirements for the project.

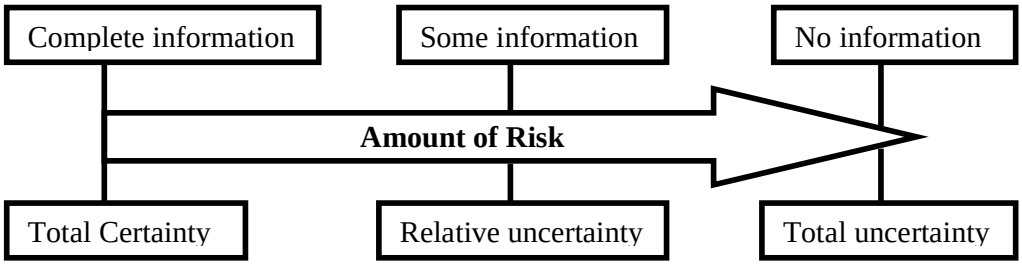
Accordingly, in this section concept of risk, risk on construction project, procurement method, contract and risk, risk management process, risk classification, objective of risk management, the three basic type of project delivery system and others are discussed.

2.2 CONCEPT OF RISK

The concept of risk is multi dimensional. According to Goncalves and Heda (2014) the core concept of risk is that it is the probability of occurrence of an unfavorable outcome and the consequence of that outcome. This implies that, if either the probability of occurrence or the impact or consequence of the occurrence increase, the risk increases. However, there is not a one to one relationship between the increase in probability and/or consequence and risk. In other words, the relationship is nonlinear.

Based on project risk management, uncertainty is defined as an absence of information, knowledge, or understanding regarding the outcome of an action, decision, or event. Project managers constantly suffer from an absence of information, knowledge, or understanding. Risk is actually a measure of the amount of uncertainty that exists. It’s directly tied to information, as Figure 2-1 illustrates. In the world of project management, risk relates

primarily to the extent of someone's ability to predict a particular outcome with certainty Heerkens (2002).



adapted from Heerkens (2002), page 142.

Figure 2.1 Risk relationship between information and uncertainty.

According to Jon Tapping and Rob Stott (2012) the concept of risk can include positive and negative impacts. This means that the word "risk" can be used to describe uncertainties that, if they occurred, would have a negative or harmful effect. The same word can also describe uncertainties that, if they occurred, would be helpful. In short, there are two sides to risk: threats and opportunities. As stated by Heerkens (2002) threats are the negative or "downside" effects of risk and opportunities are often referred to as positive effects of risk. Threats are specific events that drive your project in the direction of outcomes viewed as unfavorable (e.g., schedule delays, cost overruns, and inferior product performance). In the context of construction industry, the probability of a definite factor detrimental (harmful) to the overall project occurs is always present. A lack of predictability related to the consequence that results can either be better than expected or can be worse Ehsan *et al.* (2010).

Smith *et al.* (2006) defined risk and uncertainty as: risk exists when a decision is expressed in terms of a range of possible outcomes and when known probabilities can be attached to the outcomes; uncertainty exists when there is more than one possible outcome of a course of action but the probability of each outcome is not known (frequently termed estimating uncertainty). In other word as stated by Chia (2006) cited in Morote and Vila (2011) risk is the probability of the future event occurring must be greater than 0% but less than 100%. Future events that have a zero or 100% chance of occurrence are not risks. To mean that an event is assumed to be certain if the probability of its occurrence is 100% or totally uncertain if the probability of its occurrence is 0%.

As stated in Saunders (2016) paper by considering the definition of the term risk and uncertainty summarized their characteristics in the context of project management as shown in the Table below.

Table 2.1 The characteristics of risk and uncertainty in the context of project management

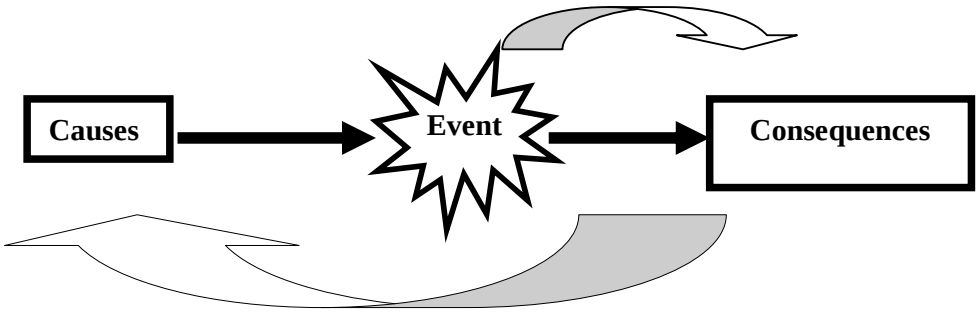
Risk characteristics	Uncertainty characteristics
Occurrence or event based;	State of unknowing;
Quantifiable , often estimable (valuable) probabilities of occurrence;	Lack of information;
Are the consequence of uncertainty;	Less susceptible to analysis, involving variability and ambiguity;
Socially constructed;	The consequences are project risk;
An impact on project if they occur.	Subjective phenomenon;
	Can be positive or negative

adapted from Saunders (2016), page 2-7.

In a project context, risk is a chance of something that will have an impact upon objectives. It includes the possibility of loss or gain, or variation from a desired planned outcome, as a consequence of the uncertainty associated with following a particular course of action. Similarly, concerning about potential impacts on project objectives; project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality. A risk may have one or more causes and, if it occurs, it may have one or more impacts OPMPI (2003) and PMBOK (2013).The uncertainty may be about a future event that may or may not happen and the unknown magnitude of the impact on project objectives if it does happen Jackson (2004). A cause may be a given or potential requirement, assumption, constraint, or condition that creates the possibility of negative or positive outcomes PMBOK (2013). Thus, a "risk" is characterized by its probability of occurrence and its uncertain impact on project objectives Jackson (2004). It has two elements: the likelihood or probability of something happening, and the consequences or impacts if it does Cooper *et al.*(2005).

As stated in UNESCO (2010) risks are expressed as a cause and effect relationship. Understanding the most important cause helps formulate the best possible actions to manage an uncertainty (i.e. treating the root cause instead of the symptom). Understanding the most important effect helps formulate the best possible contingency plan in case an uncertainty does happen with negative impact. The author further states that the key word in the definition of risk is uncertain event. Clearly the term uncertain event needs to be interpreted broadly to cover many different situations but it needs to be sharp enough to allow the identification of the causes leading to the event, their effect or consequence (as illustrated in the cause-and-effect diagram below) and thus the measures that can be taken to manage the risk.

Accordingly, this paper conceptualize risks based on cause and effect relationship in agreement with UNESCO (2010). Since risk has three components i.e. a cause for an event, the event, and the consequence of the happening of the event.



adopted from UNESCO (2010).

Figure 2.2 Cause and effect diagram

2.3 RISK ON CONSTRUCTION PROJECT

No construction project is risk free. Risk can be managed, minimized, shared, transferred, or accepted. It cannot be ignored Latham (1994) cited by Othman and Harinarain (2009). The size of the project being small or large, factors such as location, complexity, build-ability, and type of building can all contribute to the risk. Khumpaisal (2007), Zou *et al.*(2007) and El-karim *et al.*(2015) stated and identified in their research paper some of the major risks usually found in construction projects and key risks of a contractor on a construction project respectively as shown in the Table 2.2 below.

Table 2.2 Some of the major risks and key risks of a contractor on a construction project.

Item no	Author	Title	Risk type
1	**Khumpaisal (2007)**	**Risks in the construction project procurement process and the mitigation methods.**	Some of the major risks usually found in construction projects includes: ➢ delay in letting contract; ➢ obtaining appropriate approvals; ➢ poor tenders; ➢ technological improvements; ➢ construction material delays; ➢ construction equipment delays; ➢ material quality and specifications; ➢ industrial action; ➢ inclement weather; ➢ occupational, health, welfare and safety.
2	**Zou *et al.*(2007)**	**Identifying key risks in construction**	The key risks of a contractor on a construction project includes:

		projects: life cycle and stakeholder perspectives.	➢ "unsuitable construction program planning" may result from inadequate program scheduling, innovative design or contractors' lack of knowledge in planning construction programs. ➢ variation of construction program; ➢ "lack of coordination from project participant" may lead to confusion in the management of construction team and programs. ➢ unavailability of sufficient professionals and managers; ➢ unavailability of sufficient amount of skilled labour; ➢ "occurrence of dispute" exists in most construction projects, on account of the discrepancy and variations in the design and construction. ➢ serious noise pollution caused by construction; ➢ general safety accident occurrence.
3	**El-karim *et al.*(2015)**	**Identification and assessment of risk factors affecting construction projects.**	The key risks of a contractor on a construction project includes: ➢ different site condition; ➢ labour skill level and drop productivity;

			➢ equipment productivity and break down; ➢ material delivery; ➢ storage, theft, damage, monopoly; ➢ design error; ➢ defective work; ➢ prequalification; ➢ quality control process; ➢ fluctuation in price; ➢ delayed payment; ➢ bureaucracy of the government; ➢ change in law and regulation.

Further to this the key areas of risk for a principal (the client/ employer) is different to those applying to a contractor and different again from those applying to a financier (financial institution/client itself). According to Mead (2007) the client/ employer is generally concerned that the project will be: feasible, in the sense that the project will "stack up" financially; able to proceed, in the sense of having obtained requisite site, planning and other approvals; able to be completed within budget (or allowed contingency) and on time having regard to the timing of end user requirements; able to satisfy end user requirements; fit for purpose, in the sense of it meeting design, construction and performance criteria.

On the other hand, the contractors' key concerns are generally: to be paid in accordance with the terms of the contract including any additional amounts owing because of variation, etc; to achieve its aimed for margin; to complete in accordance with its program; to have had the contract fairly administered; to have avoided liability to third parties or the principal, e.g. liquidated damages, etc Mead (2007). At the end the author states that a financier of the project considers other key areas of risk which include: completion risk; resource or reserves risk; security of tenure and political risk; raw materials and supplies risk; operating risk; market risk; financial risk; force majeure risk.

Other heads of risk in the construction industry which may be of concern (to varying degrees) for all stakeholders include: damage to persons; property or works; contractual; design/construction; operating; financial and funding; construction performance; design; compliance with legislative requirements; workplace health and safety; environmental; cultural heritage; taxation; currency; change in government; political; site conditions (e.g. latent conditions); site access; technology; supply; force majeure; interface; inclement weather; industrial relations; legal (change of legislation); insurance; disputation; insolvency; consumption; safety; escalation; interpretation Mead (2007).

In this regard it is important to distinguish the sources of risk from their effects. Table 2.3 below summarizes the source of risk in construction projects and the most serious effect.

Table 2.3 Summary of source of risk and the most serious effects in construction project

Sources of risk	The most serious effects of risk
Flanagan and Norman (1993); ➢ inflation rising above the allowance in the estimate; ➢ unforeseen adverse ground conditions; ➢ exceptionally inclement weather; ➢ late delivery of crucial materials, for instance after a fire at a suppliers' works; ➢ incorrect design details, such as the wrong size beams being shown on the architect's drawings; ➢ insolvency of the main contractor; ➢ no co-ordination, for instance between the mechanical services contractor's drawings and the	Flanagan and Norman (1993); ➢ failure to keep within the cost estimate; ➢ failure to achieve the required completion date; ➢ failure to achieve the required quality; ➢ failure of the project to meet the required operation needs; ➢ damage to the property as a result of fire or flood; ➢ injury to a worker due to an inadequate system of working.

suspended ceiling specialist's drawings. Ehsan *et al*.(2010); ➢ changes in project scope and requirements; ➢ design errors and omissions; ➢ inadequately defined roles and responsibilities; ➢ insufficiently skilled staff; ➢ subcontractors; ➢ inadequate contractor experience; ➢ uncertainty about the fundamental relationships between project participants; ➢ new technology; ➢ unfamiliarity with local conditions; ➢ force majeure.	

adapted from Flanagan and Norman (1993) and Ehsan *et al*.(2010).

Ultimately, all risk encountered on a project is related to one or more of the following: failure to keep within the cost budget/forecast/estimate/tender; the time stipulated for the approvals, design, construction and occupancy; the required technical standards for quality, function, fitness for purpose, safety and environment preservation Flanagan and Norman (1993).

As stated by Chege and Rwelamile (2000) in the construction industry projects frequently run into problems and fail to meet the desired objectives. Risk management seeks to ensure that all goes according to plan and the project objectives are achieved. Several different types of procurement systems have evolved over the years from the traditional procurement model with the aim of facilitating the achievement of the project objectives. As different procurement options imply different ranges of responsibilities and liabilities in the project, selecting an appropriate project procurement option is a key issue for project actors Osipova (2008). In addition, different procurement strategies are also being used as techniques for

risk allocation, management, and control the likelihood of risk events such as time and cost overruns from occurring. Further to this one of the main objectives of any procurement system/ method is to secure an optimum level of risk transfer between the client and the contractor Chege and Rwelamile (2000). In view of that, it is necessary to discuss procurement method in relation to risk and this will be dealt in the next section (section 2.4).

2.4 PROCUREMENT METHOD

A project may be regarded as successful if the building is delivered at the right time, at the appropriate price and quality standards, and provides the client with a high level of satisfaction. One important influence on this is the type of procurement method implemented Love *et al.*(1998). Molenaar *et al.* (2009) cited by Ghadamsi and Braimah (2010) defined procurement method as a comprehensive process by which designers, contractors, and various consultants provide services for design and construction to deliver a complete project to the client. As this definition suggests, different processes such as: project brief, feasibility study, concept design, tender and contract, construction and commission and hand over Rashid *et al.*(2006); are involved in a procurement strategy. These processes are often interrelated and sequential in nature and their effectiveness and efficiency impact considerably on the success or failure of projects.

As stated by Chege and Rwelamile (2000) one of the main objectives of any procurement system (or sometimes known as delivery system Love *et al.* (1998)) is to secure an optimum level of risk transfer between the client and the contractor. This is one of the reasons why alternative forms of procurement, for example, management contracting, design and build, build operate and transfer (BOT), design build finance operate (DBFO), prime contracting and hybrids of these procurement systems have been used in lieu of the traditional procurement model. The main aim of utilizing these other procurement models is to transfer the risk to the party that is best able to deal with it. Some projects involve a higher level of risk than other projects. It is therefore very important that the client chooses the procurement system that is best suited for the particular project after analyzing the risks involved.

In dealing which procurement system to apply, various factors have to be taken into consideration before any informed decision can be made on the right procurement choice.

According to Love *et al.* (2008), Ghadamsi and Braimah (2010), and Ratnasabapathy *et al.* (2006) the factors can be classified into two groups:

- External environment such as economics, politics, finance, legal, nature disasters, technology factors, and;
- Internal environment which can be divided under three main factors; project characteristics, client's characteristics and client's requirement. Client requirements can be sub-divided into cost related factors, time related factors and quality related factors.

By considering these factors the selection of suitable procurement method is important to the successes of any project. Because, the wrong selection of construction procurement approach usually leads to project failure or general client's dissatisfaction Ratnasabapathy *et al.* (2006). Also it increases the probability of risk events occurring within the project Chege and Rwelamile (2000). On contrary, selecting an appropriate procurement system/ method can be effective in mitigating the risk inherent in a project Love *et al.*(2008). Therefore, a systematic approach for the selection of the most appropriate system is essential to aid the clients to achieve their ultimate project goals, thus to ensure best value for their money.

In addition to this project performance is highly influenced by the type of construction procurement method used to deliver the project. By virtue of this relationship, project clients often seek to select the best method that will help achieve better project performance Ratnasabapathy *et al.*(2006). Moreover, there are some criteria to establish a profile of the client requirement and 'experts' preferences for the performance of each procurement methods such as: speed (during design and construction), certainty, flexibility in accommodating design changes, quality, complexity, risk allocation/avoidance, responsibility, price competition and dispute and arbitration Love *et al.*(1998), Ghadamsi and Braimah (2010) and Lin *et al.* (2014).

As this paper focuses on building contractors risk sources associated with the contract's delivered through the PPPAA's (2011) standard bidding document for the procurement of works in Ethiopia Harinarain *et al.*(2008) cites Harinarain *et al.* (2007) states that risk sources to the contractor could be defined as the person, authority or event that either reduce the strength of the company, increase its weakness, reduce its opportunities and increase its

treats, which eventually affects the achievement of the project objectives and client satisfaction.

2.5 CONTRACT AND RISK

Project risk management is beneficial if it is implemented in a systematic manner from planning stage through the project completion. The unsystematic and arbitrary risk management can endanger the success of the project since most of the risks are very dynamic throughout the project life time Morote and Vila (2011). Several risk management approaches are proposed on the subject of risk management. Some of the most important approaches are: PRAM (program risk analysis and management) Chapman (1997), RAMP (risk analysis and management for project) Institution of Civil Engineering (2002), PMBOK (PMI)(2008), RMS (risk management standards) Institute of Risk Management (2002) cited by Morote and Vila (2011). All of these approaches may be summarized in to a six phase processes for effective project risk management. That is, planning risk management, identifying risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk responses, and control risk. The detail of these processes will be discussed in the next section.

According to Jardine (2007) and Gunn (2009) integrating risk with other project management functions, project risks include:

- Cost management;
- Time management (Schedule/Program)
- Scope and change management;
- Quality and safety;
- Procurement and contracts;
- People management,
- information management; and
- external influence.

Therefore, by considering a contract, it can be used as a risk managing tool by allocating risks to the various agencies through the various contracts between them Pawar *et al.* (2015). In addition, it establishes the rights, duties, obligations, and responsibilities of the parties and to allocate risk Flanagan and Norman (1993). Risk allocation strategy in construction projects is defined through the contractual arrangements Osipova (2008).The building contract is an agreement between two parties, one of whom, the building

contractor, agrees to erect a building, the other, the employer, agrees to pay for it. Personal rights and obligations are created by the agreement, and the right of one party is the obligation of the other Harinarain *et al.*(2008).

Construction project is a very risky business, for both the owner and the contractor because of the complexity in coordinating various processes. Besides, many parties are involved such as owner, consultant, contractor, subcontractor, and supplier Banaitiene and Banaitis (2012). Each project is unique and often incorporated with new techniques and procedures Karim *et al.*(2012). Also, it is a time consuming process involving a multitude of organizations with different objectives and skills. Moreover, increasing client expectations coupled with the technological development of materials and equipment Othman and Harinarain (2009).

Part of the challenge is trying to place the risk in the hands of the party that can best manage that risk. That's why an owner hires a contractor to begin with to shift the risks for the construction cost, time, quality, and safety over to someone trained to manage them. Once the risks are identified, understood, and analyzed, proper allocations can be made for reasonable schedules, estimates, and management plans Jackson (2004).

Almost every construction project carry with them enormous risks and therefore the construction industry is subject to more risk and uncertainty than most other industries Dutta (2014) and Tadayon *et al.*(2012) such as: textile and steel manufacturing. Since, construction activity involves a number of agencies like the owner; consultant and the contractor may have conflicting interests. In order to establish the duties, obligations, rights, responsibilities amongst the agencies, a contract is required to be made between them which will establish a mutual relationship to do a work Pawar *et al.*(2015).

As a result, one of the purpose of the contract is to allocate the risk and to minimize risks and their consequence if utilized well Mesfin (2014) and Flanagan and Norman (1993). The acceptance of an obligation or duty brings with it the acceptance of a commensurate risk, which is the risk of being unable to fulfill the obligation or duty because of one's own inadequacy, incapacity, inadvertence, or error, or because of interference from outside source or events. But with any contractual agreement the contract defines only the ground rules, the execution of the contract rests on goodwill, intent and the relationship between the parties Flanagan and Norman (1993).

The parties to contract should understand that risk management is not the responsibility of one party but the combined effort of all those involved. Each one should know the quantum (amount) of risk they are exposed to and prepare themselves for the risk. Risk is to be redirected or avoided or transferred to a particular project participant is a question that needs to be answered Kalkhoran *et al.*(2014) and Tapping and Stott (2012). According to Shuibo *et al.* (2006) a contract is used to allocate risks, in the contracts, among the parties in such a way as to enable risks to be managed efficiently and effectively throughout the construction process. Risk in contractual work involves the possibility of gain or loss that may occur during the course of a project**.** In determining contract strategy, both the parties should strive to understand and recognize each other's responsibility Kalkhoran *et al.*(2014).The issue of the way to effectively handle the risks which are inherent in any construction contract depends on different factors. As stated by Taylor and Mbachu (2014) factors due to the nature of the work, current workload / the desire of the company to have the project, the need for work, reliability or unreliability of a company's pricing approach, and risks based on the perceived competitiveness of other bids. The handling of risk in construction contracts varies significantly. This depends on the nature and location of the work, the owner/client and contractor involved and the prevailing (existing) contracting climate Dutta (2014).

The contract for construction is made up of much more than just a simple agreement form. Although an agreement form is eventually executed between the owner and the contractor, there are many more documents such as: general conditions, supplementary conditions, drawings, bills of quantities and addendums that direct the construction of the project and responsibilities of the parties Jackson (2004). In a contract between owner and contractor, there is an implied warranty that the contractor undertakes: to do work with care and skill in a workmanlike manner; to use materials of good quality; and that both the work and materials will be reasonably fit for the purpose for which they are required Bunni (2003).Contracts of all size and for all purposes are intended to transfer risks, allocating them to an individual or an organization to be managed for the duration of the arrangement Cooper *et al.*(2005).

In building or construction contracts whenever someone holds himself out to be specially qualified to do a particular type of work, there is an implied warranty that the work will be done in a workmanlike manner and that the resulting building, product, etc., will be

reasonably fit for its intended use. Thus, the contractor is required to bring his expertise into play and to notify even an architect (expert) of reasonably discovered defects Bunni (2003). According to Dutta (2014) one of the major risks faced by construction industry is "CONTRACT RISK". Accordingly, as shown in Table below type of risks in a construction contract are: physical works, delay and disputes, direction and supervision, damage and injury to persons and property, external factors, payment, and law and arbitration Abrahamson (1984), and Bunni (1985) cited by Murdoch and Hughes (2002). Since, it is difficult to remove all potential risks in a construction project, thus it is crucial to allocate risks among parties in the project through a contract. If not, project performance in terms of cost, quality and time is often affected. Moreover, disputes and misunderstandings are often the end result between clients and contractors when the distribution of risk is not well allocated Olamiwale (2014). Therefore, proper risk allocations in construction contracts can help reduce such impacts and achieve management efficiency Shuibo *et al.*(2006).

Table 2.4 Type of risk in construction contract

№	**Type of risk in construction contract**	
1	**Physical works**	ground conditions; artificial obstructions; defective materials or workmanship; tests and samples; weather; site preparation; inadequacy of staff, labour, plant, materials, time or finance.
2	**Delay and disputes**	possession of site; late supply of information; inefficient execution of work; delay outside both parties' control; layout disputes.
3	**Direction and supervision**	greed (insatiability); incompetence; inefficiency; unreasonableness; partiality; poor communication; mistakes in documents; defective designs; compliance with requirements; unclear requirements; inappropriate consultants or contractors; changes in requirements.
4	**Damage and injury to persons and property**	negligence or breach of warranty; uninsurable matters; accidents; uninsurable risks; consequential losses; exclusions, gaps and time limits in insurance cover.
5	**External factors**	government policy on taxes, labour, safety or other laws; planning approvals; financial constraints; energy or pay restraints; cost of war or civil commotion; malicious damage; intimidation; industrial disputes.

6	**Payment**	delay in settling claims and certifying; delay in payment; legal limits on recovery of interest; insolvency; funding constraints; shortcomings in the measure and value process; exchange rates; inflation.
7	**Law and arbitration**	delay in resolving disputes; injustice; uncertainty due to lack of records or ambiguity of contract; cost of obtaining decision; enforcing decisions; changes in statutes.

adopted from Murdoch and Hughes (2002),page 83.

The owner's/client's primary objective when planning construction is entirely a complete and serviceable facility in a well-timed manner. Every contract, project and client/contractor relationship is exclusive. Contract document does not give a preconceived single solution or recommendation for or against contract styles such as Engineering Procurement Installation and Construction or 'lump sum'. It aims at commenting on some of the problems that may need to be addressed in varied contracting situations Dutta (2014).

There are different risk management techniques used in different stages of the construction in the outside world; Risk management in the contractual stage, i.e. before signing the contract is used very frequently Mesfin (2014). According to Akintoye and MacLeod (1997) on the UK construction industry the general contractor and project management practice mostly rely on professional judgment, intuition and experience. In addition to this Baker *et al.*(1999) cited by Osipova (2008) found that risk reduction is the most frequently used technique within the construction industry in the UK. The results of the study conducted by Simu (2006)show that the Swedish contractors rely on their own gut-feeling and traditional ways of controlling the project rather than on established risk management systems.

In developing countries such as: Pakistan most common risk management technique practiced in its construction industry are preventive techniques and remedial technique. Preventive techniques; which can be used before the start of a project to manage risks that are anticipated during project execution. Remedial techniques that are used during project the execution phase once a risk has already occurred Iqbal *et al.* (2015). Similarly, the risk identification techniques more frequently applied in construction in Rio de Janeiro State (Brazil) are checklist, flowchart and brainstorming Garrido *et al.*(2011).According to the Chinese construction industry most frequently applied management techniques are

“brainstorming” for identifying risks, “joint evaluation by key participants” in risk analysis, “reducing risks” within risk response strategies, and “periodic document reviews” in risk monitoring Tang *et al.*(2007). The author further states that the qualitative techniques are used much more often than quantitative techniques in the industry.

Lithuanian construction companies use qualitative method of risk assessment most frequently a head of quantitative method Banaitiene and Banaitis (2012). In Iran, "brain-storming sessions" is the most popular method used frequently to identify the risks in large construction projects Tadayon *et al.*(2012). In the Malaysian construction industry, financial risk and time risk are found to be the major risks in terms of the occurrence frequency and the impacts Goh and Abdul-Rahman (2013). In Iran, the most considerable types of risk in construction projects are financial risks, construction risks, and demand or product risks Tadayon *et al.*(2012). The unique risk associated in the Chinese construction project are project funding problem, contractors poor management ability, difficulty to reimbursement (payment or compensation), unwillingness to buy insurance and lack of awareness of construction safety. These recognized risks are mainly related to contractor followed by client, designers, subcontractors or suppliers and governmental agencies Zou *et al.*(2007).

If risks are identified and allocated to the contracting parties in the contract document, it makes dealing with the risks if and when they arise very easy. A construction contract risk management approach that uses a team of experienced construction professionals or experts will lead to better achievement of project objectives. According to the parties involved in Ethiopian building construction projects, most projects are not completed in conformity to the original plan i.e. they face various problems and changes that lead to delay, cost overrun or lower quality. The risks involved throughout the life of a building project might be causes for variations in project objectives if they are not managed well Mesfin (2014).

How risks are shared among the actors in a construction project is to a large extent governed by the choice of project delivery option (the detail will be discussed in section 2.10). There are advantages and disadvantages to each type of project delivery methods. It's the owners job to select the best project delivery method relative to the requirements for the project. Some of the factors that influence an owner's project delivery selection include cost, schedule, quality, design, risk tolerance, and construction experts Jackson (2004). As different project delivery options imply different ranges of responsibilities and liabilities in

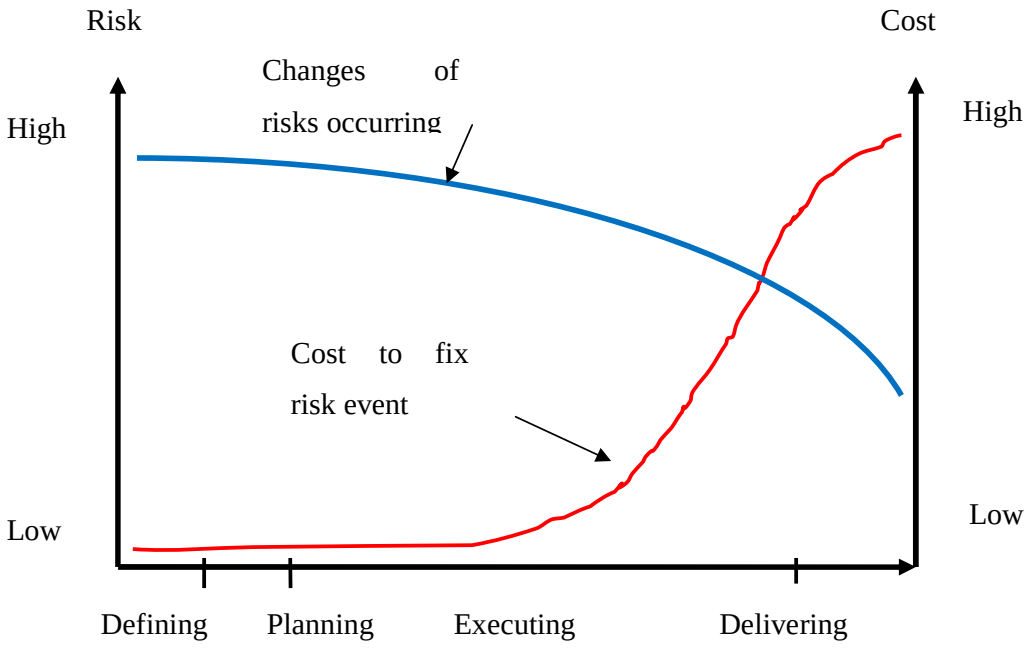
the project, selecting an appropriate project delivery option is a key issue for project actors Tsegaye (2009).

Many countries have developed standardized conditions of contract that are intended to be used in construction projects. For example , in Sweden, “General Conditions of Contract for Building, Civil Engineering and Installation Work” (AB) are used in DBB projects. ”General Conditions of Contract for Building, Civil Engineering and Installation Work performed on a package deal basis” (ABT) are used in design-build projects. AB and ABT assign responsibilities and liabilities of each contracting party regarding job performance, organization, time frames, guarantees, insurances, errors and payment Osipova (2008).In Ethiopia a traditional project delivery method that is DBB contract is widely applied. In this type of contract the client/ owner holds two separate contracts for design and construction. This implies that the client is responsible for the design and the contractor for the execution. In addition to this we can observe that a number of standard forms of construction contracts have been formulated and put in use. The well known ones are: The Standard Conditions of Contract for Construction of Civil Work Projects that was authored by the Ministry of Works and Urban Development (MoWUD) in May 1994; Building and Transport Construction Design Authority (BATCoDA) Standard Conditions of Consulting Services for Design and Supervision of Construction Works, January 1990; and The Standard Bidding Document (SBD) for the Procurement of Works, issued by the Public Procurement and Property Administration Agency (PPPAA), January 2006 and 2011. The PPPAA is established under the Ministry of Finance and Economic Development (MoFED) by virtue of the Federal Public Procurement Proclamation No.430/1997.

2.6 RISK MANAGEMENT PROCESS

According to Larson *et al.* (2011) the chances of a risk event occurring (e.g., an error in time estimates, cost estimates, or design technology) are greatest in the concept, planning, and start up phases of the project. The cost impact of a risk event in the project is less if the event occurs earlier rather than later. The early stages of the project represent the period when the opportunity for minimizing the impact or working around a potential risk exists. Conversely, as the project passes the halfway implementation mark, the cost of a risk event occurring increases rapidly. For example, consider the process of building a new home. It would be economical to decide to add extra electrical and sanitary outlets during the structural framing stage than it would be to make that decision after the structural framing

and the drywall was up and the walls were painted. It would be even more cost effective to make that decision while the plans were still on the drawing board. Figure 2.3 below presents a graphic model of the risk management challenge within the project life.



adopted from Larson *et al.* (2011) p.212.

Figure 2.3 Graphic model of the risk management challenge within the project life

In this regard, the risk management process can be defined as a logically consistent framework used to develop the process of finding and understanding alternative risks, assessing their risk and uncertainties, identifying the resources needed and choosing appropriate courses of action to address these risk factors and achieve the desired results. Since, as mentioned in the previous chapter the construction industry is subject to more risk and uncertainty than many other industries Dutta (2014) and Tadayon *et al.*(2012). In addition to this several risk management approaches are proposed on the subject of risk management. Furthermore a number of variations risk management process have been proposed in literature.

As stated by Smith *et al.*(2006) the risk management cycle that includes the identification, analysis and control of risks to be applied at corporate, strategic business and project levels. The risk management cycle is dynamic and must be continuous over the project investment

life cycle. Cooper *et al.* (2005) defines risk management process in seven steps; communicate and consult, establish the context, identify risks, analyze risks, evaluate risks ,Treat risks and monitor and review. According to Kerzner (2009) it is important that a risk management strategy be established early in a project and that risk be continually addressed throughout the project life cycle. Risk management includes several related actions, including risk: planning, identification, analysis, response (handling), and monitoring and control.

PMBOK (2013) defines risk management process as six processes as follow **:** plan risk management**,** identify risks, perform qualitative risk analysis, perform quantitative risk analysis **,** plan risk responses and control risks. Meredith and Mantel (2009) added the seventh sub process on PMBOK which is, create and maintain a risk management data bank a permanent record of identified risks, methods used to mitigate or resolve them, and the results of all risk management activities. Mhetre *et al.* (2016) states risk management is the process which consists of identification, assessment, response and review. Similarly, Porananond *et al.* (2014) summaries the key steps of project risk management process as scope and context planning, risk identification, risk analysis, risk treatment and risk control. These authors further stated the comparison between the process steps for risk management in relation to the standards and PMBOK as shown in the Tables 2.5 and 2.6. The first Table summarizes the standards and PMBOK related to Project Risk Management. The second Table compares the process steps for risk management in relation to the standards and PMBOK.

According to Goh and Abdul-Rahman (2013) an effective implementation of a risk management system not only brings a higher level of awareness of the consequences of risk but also focuses on a more structured approach, more effective centralized control and better transfer of risk information between parties. This author further states that successful risk management should convert uncertainty to risk and convert risk to opportunity. The project and organization would hence achieve more gains by maximizing opportunity, minimizing risk and reducing uncertainty. Accordingly, a risk management process (RMP) described by PMBOK (2013) has been chosen for the purpose of this paper. This section will further explain the RMP, its six stages with inputs, tools and techniques and outputs respectively.

Table 2.5 Summary of standards and PMBOK related to Project Risk Management

Standard	Relation to Project Management	Risk Management Process
AS/NZS 4360:2004 Risk Management	Included but not specific to project risks	**Defines risk management process as** 1) Communicate and consult; 2) Establish the context;3) Identify risks; 4) Analyze risks,5) Evaluate risks; 6) Treat risks; 7) Monitor and review
ISO31000:2009 Risk management	Included but not specific to project risks	**Defines risk management process as** 1) Communication and consultation;2) Establishing the context; 3) Risk assessment; 4) Risk treatment; 5) Monitoring and review
ISO10006:2003 Guidelines for quality management in projects	**Defines project management to 7 process grouping for** 1) Inter dependency-related processes,2) Scope-related processes,3) Time-related processes,4) Cost-related processes,5) Communication-related processes,6) Risk-related processes, and7) Purchasing-related processes	**Defines risk-related processes group as 4 processes** 1) Risk identification; 2) Risk assessment; 3) Risk treatment; 4) Risk control

ISO21500:2012 Guidance on project management	**Defines project management to 10 subject groups for** 1) Integration, 2) Stakeholder,3) Scope, 4) Resource,5) Time, 6) Cost ,7) Risk , 8) Quality,9) Procurement and10) Communication.	**Defines risk subject group into 4 processes** 1) Identify risks,2) Assess risk, 3) Treat risk, and 4) Control risks
PMBOK 5th Edition PMI, (2013)	**Defines 10 knowledge area for** 1) Project integration management, 2) Project scope management, 3) Project time management, 4) Project cost management, 5) Project quality management, 6) Project human resource management , 7) Project communication management , 8) Project risk management, 9) Project procurement management and 10) Project stakeholder management.	**Defines risk management process as 6 processes as following** 1) Plan risk management,2) Identify risks, 3) Perform qualitative risk analysis, 4) Perform quantitative risk analysis,5) Plan risk responses and 6) Control risks

adopted Porananond *et al.*(2014).

Table 2.6 Comparison of risk management process in standard and PMBOK

	AS/NZS 4360 (2004)	ISO 31000 (2009)	ISO 10006 (2003)	ISO 21500 (2012)	PMBOK (2013)
Scope and context planning	Communicate and consult	Communicate and consult			Plan risk Management
	Establish the context	Establish the context			
Risk Identification	Identify risk	Risk assessment (ISO 31000) -Identification -Analysis -Evaluation	Risk identification	Risk identification	Identify risk
Risk Analysis	Analyze Risk		Risk assessment	Assess risk	Perform qualitative analysis
	Evaluate Risk				Perform quantitative analysis
Risk treatment	Treat Risk	Risk treatment	Risk treatment	Treat risks	Plan risk responses
Risk control		Monitoring and review	Risk control	Control risk	Control risk

adopted Porananond *et al.*(2014) and Cooper *et al.* (2005) .

2.6.1 PLAN RISK MANAGEMENT

According to PMBOK (2013) it is the process of defining how to conduct risk management activities for a project. According to WSDOT(2014) it is the systematic process of deciding how to approach, plan, and execute risk management activities throughout the life of a project. It is intended to maximize the beneficial outcome of the opportunities and minimize or eliminate the consequences of adverse risk events. Similarly; according to OPMPI (2003) and PMBOK (2013)project risk management is the systematic process of planning for project risk. It involves processes, tools, and techniques that will help the project manager maximize the probability and consequences of positive events and minimize the probability and consequences of adverse events. And thus, the system must be practical, realistic and must be cost effective.

Smith *et al.* (2006) developing a project plan has three benefits; these are:

1. Planning reduces uncertainty even though you would never expect the project work to occur exactly as planned, planning the work enables you to consider the likely outcomes and to put the necessary corrective measures in place when things don't happen according to plan.
2. The mere (simple) act of planning gives you a better understanding of the goals and objectives of the project. Even if you were to discard the plan, you would still benefit from having done the exercise.
3. Planning improves your efficiency that is, after you have defined the project plan and the necessary resources to carry out the plan, you can schedule the work to take advantage of resource availability. You also can schedule work in parallel that is, you can do tasks concurrently, rather than in series. By doing tasks concurrently, you can shorten the total duration of the project. You can maximize your use of resources and complete the project work in less time than by taking other approaches. Not knowing the parameters of a project prevents measurement of progress and results in never knowing when the project is complete. The plan also provides a basis for measuring work planned against work performed.

Similarly PMBOK (2013) describes; the key benefit of this process is that it ensures that the degree, type, and visibility of risk management are commensurate (appropriate) with both the risks and the importance of the project to the organization. According to; PMI (2009) the objective of this process are to develop the overall risk management strategy for the project,

to decide how the risk management process will be executed, and to integrate project risk management with all other project activities. In addition to this PMBOK (2013); Careful and explicit (clear) planning enhances the probability of success for other risk management processes. Planning is also important to provide sufficient resources and time for risk management activities and to establish an agreed upon basis for evaluating risks. The Plan Risk Management process should begin when a project is conceived (imagined) and should be completed early during project planning.

2.6.1.1 RISK MANAGEMENT PLAN INPUTS

According to PMBOK(2013) and Mubin and Mubin (2008) the project management plan, provides baseline or current state of risk affected areas including scope, schedule, and cost. The enterprise environmental factors include, but are not limited to, risk attitudes, thresholds, and tolerances that describe the degree of risk that an organization will withstand. The organizational process include, but are not limited to: risk categories, common definitions of concepts and terms ,risk statement formats, standard templates, roles and responsibilities, authority levels for decision making, and lessons learned. PMBOK (2013) the project charter can provide various inputs such as high-level risks, high-level project descriptions, and high-level requirements. The stakeholder register, which contains all details related to the project's stakeholders, provides an overview of their roles.

2.6.1.2 RISK MANAGEMENT PLAN TOOLS AND TECHNIQUES

According to PMBOK(2013) & Mubin and Mubin (2008) it is analytical techniques; which are used to understand and define the overall risk management context of the project. Meetings; project teams hold planning meetings. Attendees at these meetings may include the project manager, selected project team members and stakeholders, anyone in the organization with responsibility to manage the risk planning and execution activities, and others, as needed. Risk contingency reserve application approaches may be established or reviewed. Risk management responsibilities should be assigned. General organizational templates for risk categories and definitions of terms such as levels of risk, probability by type of risk, impact by type of objectives, and the probability and impact matrix will be tailored to the specific project. If templates for other steps in the process do not exist, they may be generated in these meetings.

The outputs of these activities are summarized in the risk management plan. According to PMBOK (2013) expert judgment; judgment, and expertise should be considered from groups

or individuals with specialized training or knowledge on the subject area, such as: Senior management, Project stakeholders, Project managers who have worked on projects in the same area (directly or through lessons learned),Subject matter experts (SMEs) in business or project area, Industry groups and consultants, and Professional and technical associations.

2.6.1.3 RISK MANAGEMENT PLAN OUT PUTS

According to PMBOK (2013) the risk management plan is a component of the project management plan and describes how risk management activities will be structured and performed. The risk management plan out puts includes the following: PMBOK (2013) and Newton (2015).

Table 2.7 Risk management plan Out puts

No	Out puts	Scope
1	**Methodology**	defines the approaches, tools, and data sources that will be used to perform risk management on the project.
2	**Roles and responsibilities**	defines the lead, support, and risk management team members for each type of activity in the risk management plan, and clarifies their responsibilities.
3	**Budgeting**	estimates funds needed, based on assigned resources, for inclusion in the cost baseline and establishes protocols for application of contingency and management reserves.
4	**Timing**	defines when and how often the risk management processes will be performed throughout the project life cycle, establishes protocols for application of schedule contingency reserves, and establishes risk management activities for inclusion in the project schedule.
5	**Risk categories**	-provide a means for grouping potential causes of risk. -It provides a structure that ensures a comprehensive process of systematically identified risks to a consistent level of detail. -An organization can use a previously used categorization frame work, which might take the form of the simple list of categories or might structured in to risk break down structure

		(RBS).
6	**A probability and impact matrix**	is a grid for mapping the probability of each risk occurrence and its impact on project objectives if that risk occurs. The specific combination of probability and impact that lead to a risk being rated as 'extreme,' 'high,' 'moderate,' 'low,' or 'nominal' importance, with the corresponding importance for planning response to the risk, are usually set by the organization.
7	**Revised stakeholders' tolerances**	as they apply to the specific project, may be revised in the Plan Risk Management process then this should be documented.
8	**Reporting formats**	-describes how the outcomes of the risk management process will be documented, analyzed, and communicated. -it describes the content and format of the risk register as well as any other risk reports required.
9	**Tracking documents**	how risk activities will be recorded for the benefit of the current project and as well as for future needs and lesson learned. And how risk management processes will be audited.

adapted from PMBOK (2013) and Newton (2015).

2.6.2 IDENTIFY RISKS

The second step in risk management process is to identify risks (risk identification).This may result from a survey of the project, customer, and users for potential concerns Kerzner (2009). The purpose of risk identification is to identify risks to the maximum extent that is practicable. The fact that some risks are unknown-able or emergent requires the identify risk process to be iterative, repeating the identify risks process to find new risks which have became knowable since the previous iteration of the process PMI(2009). According to PMBOK(2013) the process of determining which risks may affect the project and documenting their characteristics. The key benefit of this process is the documentation of existing risks and the knowledge and ability it provides to the project team to anticipate events. WSDOT (2014) risk identification occurs throughout each phase of project development: planning ; scoping, design/Plans, specifications, and estimate (engineer's estimate), construction. As projects evolve (change) through project development, the risk

profile evolves (changes) and understanding grows. Therefore, previously identified risks may change and new risks may be identified throughout the life of the project.

In addition to this, PMBOK (2013) identify risks is an iterative (repetitive) process, because new risks may evolve (change)or become known as the project progresses through its life cycle. The frequency of iteration and participation in each cycle will vary by situation. The format of the risk statements should be consistent to ensure that each risk is understood clearly and unambiguously in order to support effective analysis and response development. The risk statement should support the ability to compare the relative effect of one risk against others on the project. According to OPMPI (2003) and PMBOK(2013)risk management is the systematic process of identifying project risk. As mentioned on previous section it involves processes, tools, and techniques that will help the project manager.

2.6.2.1 INPUTS OF THE IDENTIFY RISKS PROCESS

The first and most important input is a defined project. In order to fully understand and assess the risks that our projects are exposed to, we must first ensure there is a mutual understanding of the project under evaluation. Projects tend to develop in small steps. This incremental process of project development is sometimes develop in steps, and continuing by increments WSDOT (2014).

2.6.2.2 TOOLS & TECHNIQUES OF THE IDENTIFY RISKS PROCESS

The risk identification process or the risk information gathering process can be achieved with the aid of different tools and techniques Rostami (2016). According to, PMI (2009) a range of tools & techniques is available for risk identification. These fall into the following three categories. The first category; the project historical review based on what occurred in the past, either on this project, or other similar projects in the same organization, or comparable projects in other organization. These review approaches rely on careful selection of comparable situation which are genuinely similar to the current project, and filtering of date to ensure that only relevant previous risk are considered. The second category; current (present) assessment rely on detailed consideration of the current project, analyze its characteristics against given frame works and models in order to expose areas of uncertainty. In addition this techniques do not rely on outside reference points. The last category; creative techniques (future), A wide range of creative techniques can be used for risk identification, which encourage project stake holders to use their imagination to find risks which might affect the project. These techniques can be used either singly or in groups, and employ

varying degrees of structure. According PMBOK (2013) the risk identification tools and techniques are shown in Table below.

Table 2.8 Risk identification Tools and Techniques

Nº	Tools and Techniques	Scope
1	**Documentation reviews PMBOK (2013) & Mubin and Mubin (2008)**	Peer-level reviews of project documentation, studies, reports, preliminary plans, estimates, and schedules are a common and early method to help identify risks that may affect project objectives.
2	**Information gathering techniques PMBOK (2013) &Mubin and Mubin(2008)**	
	-Brain storming	The objective of brainstorming to obtain a comprehensive list of project risks, and it is performed with a project team members, specialty groups, stakeholders, and regulatory agency representatives (multidisciplinary set of experts).Effective brain storming requires a skill facilitator, working together with the project team and specialists who can bring additional expertise.
	-Delphi Technique	The Delphi technique is a way to reach a consensus of experts. It helps to reduce bias in the data and keeps any one person from having undue influence on the outcome.
	-Interview	Interview with experienced project participants, stakeholders and subject matter experts to identify risks.
	-Root cause Analysis	a specific technique used to identify a problem, discover the underlying causes that lead to it, and develop preventive action.
3	**Check list Analysis**	Risk identification checklists can be developed based on historical information and knowledge that has

	PMBOK (2013) & Mubin *and Mubin* (2008)	been accumulated from previous similar projects and from other sources of information.
4	**Assumption Analysis PMBOK (2013) & Mubin and Mubin (2008)**	It is a tool that explores the validity of assumptions as they apply to the project. It identifies risks to the project from inaccuracy, inconsistency, or incompleteness of assumptions.
5	**Diagramming PMBOK (2013) & Mubin and Mubin (2008)**	
	- Cause and effect diagram	These are also known as Ishikawa or fishbone diagrams, and are useful for identifying causes of risks.
	-System or process flow chart	These show how various elements of a system interrelate and the mechanism of causation.
	-Influence diagram	These are graphical representations of situations showing causal influences, time ordering of events, and other relationships among variables and outcomes.
6	**SWOT analysis**	This technique examines the project from each of the strengths, weaknesses, opportunities, and threats (SWOT) perspectives to increase the breadth of identified risks by including internally generated risks.
7	**Expert Judgment**	Risks may be identified directly by experts with relevant experience with similar projects or business areas. The experts' bias should be taken into account in this process.

adapted from Mubin and Mubin (2008) and PMBOK (2013).

2.6.2.3 OUTPUT OF IDENTIFY RISKS PROCESS

According to PMBOK (2013) the primary output from Identify Risks is the initial entry into the risk register. The risk register is a document in which the results of risk analysis and risk response planning are recorded. This includes a properly structured risk description and the nominated risk owner for each risk, and may also include information on the causes and effects of the risk, trigger condition and preliminary response PMI (2009). List of identified risks should be recorded and used to support future risk identification for this and other projects. List of potential responses to a risk may sometimes be identified during the Identify Risks process. These responses, if identified in this process, should be used as inputs to the Plan Risk Responses process PMBOK (2013).

2.6.3 PERFORM QUALITATIVE RISK ANALYSIS

It is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact. The key benefit of this process is that it enables project managers to reduce the level of uncertainty and to focus on high-priority risks PMBOK (2013).It assesses the impact and likelihood of the identified risks and develops prioritized lists of these risks for further analysis or direct mitigation. The project team assesses each identified risk for its probability of occurrence and its impact on project objectives. Project teams may draw out (extract) assistance from subject matter experts or functional units to assess the risks in their respective fields WSDOT(2014).

According to Smith *et al.*(2006) a typical qualitative risk assessment usually includes the following issues: a brief description of the risk; the stages of the project when it may occur; the elements of the project that could be affected; the factors that influence it to occur; the relationship with other risks; the likelihood of it occurring; how it could affect the project.

This analysis can be used by project teams: as an initial screening or review of project risks; when a quick assessment is desired; as the preferred approach for some simpler and smaller projects where robust and/or lengthy quantitative analysis is not necessary WSDOT(2014).These relatively simple techniques apply when quick assessment is required in small and medium size projects. Also, this method is often used in case of inadequate, limited or unavailable numerical data as well as limited resources of time and money Mhetre *et al.* (2016).

Moreover, it is a rapid and cost effective means of establishing priorities for plan risk responses and lays the foundation for Perform Quantitative Risk Analysis, if required. The

perform qualitative risk analysis process is performed regularly throughout the project life cycle, as defined in the project's risk management plan PMBOK (2013).

2.6.3.1 INPUTS OF QUALITATIVE ANALYSES

The following Table describes the inputs of qualitative analyses.

Table 2.9 inputs of qualitative analyses

Nº	**Inputs**	**Scope**
1	**Risk management plan**	used in the perform qualitative risk analysis process include roles and responsibilities for conducting risk management, budgets, schedule activities for risk management, risk categories, definitions of probability and impact, the probability and impact matrix, and revised stakeholders' risk tolerances.
2	**Scope base line**	projects of a common or recurrent type tend to have more well understood risks. Projects using state of the art or first of its kind technology, and highly complex projects, tend to have more uncertainty. This can be evaluated by examining the scope baseline.
3	**Risk register**	contains the information that will be used to assess and prioritize risks.
4	**Enterprise environmental factor**	may provide insight and context to the risk assessment, such as: -industry studies of similar projects by risk specialists, and -risk databases that may be available from industry or proprietary sources.
5	**Organizational process asset**	that can influence the qualitative risk analysis process include information on prior, similar completed projects.

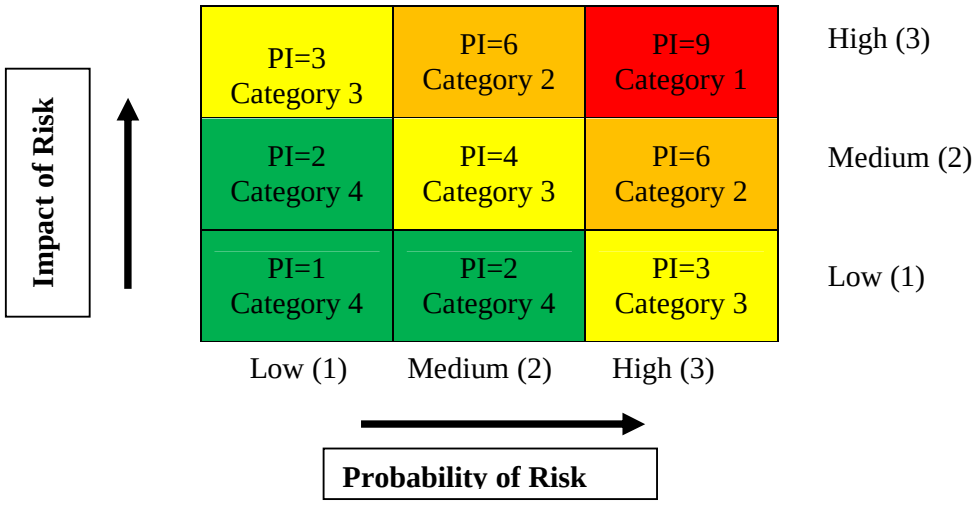
adapted from PMBOK (2013).

2.6.3.2 TOOLS AND TECHNIQUES OF QUALITATIVE RISK ANALYSES

For this analysis the tools and techniques are:

- **Risk probability and impact assessment method**; according to PMBOK (2013) and Mhetre *et al.* (2016) by applying this method the likelihood of a specific risk to occur is evaluated. Furthermore, risk impact on a project's objectives; such as schedule, cost, quality, or performance, is assessed regarding its positive effects for opportunities, as well as negative effects which result from threats. For the purpose of this assessment, probability and impact should be defined and tailored to a particular project. This means that clear definitions of scale should be drawn up and its scope depends on the project's nature, criteria and objectives.
- **Probability and impact risk rating matrix:** Probability and impact, which were assessed in the previous step, are used as a basis for quantitative analysis. Evaluation of each risk's importance and priority for attention is typically conducted using a look-up table or a probability and impact matrix. Such a matrix specifies combinations of probability and impact that lead to rating the risks as low, moderate, or high priority. Descriptive terms or numeric values can be used depending on organizational preference. Each risk is rated on its probability of occurrence and impact on an objective if it does occur. The organization should determine which combinations of probability and impact result in a classification of high risk, moderate risk, and low risk. The range of priority score, the rating and color are assigned to indicate the importance of each risk. Threats with high impact and likelihood are identified as high-risk and may require immediate response, while low priority score threats can be monitored with action being taken only if, or when, needed PMBOK (2013) and Mhetre *et al.* (2016).

  The Figure 2.4 by Mahendra *et al.*(2013) explains the above definitions. There are 4 categories defined in this diagram. Category 1 - PI (Probability and impact of risk) factor 9, which requires maximum attention Category 2 - PI Factor 6, which requires a good amount of attention Category 3 - PI Factor 3 and 4, which requires comparatively less attention to be paid Category 4 - PI Factors of 1 and 2, requires less attention to be paid.



adapted from Mahendra *et al.* (2013).

Figure 2.4 probability and impact matrix

- **Risk data quality assessment** is a technique to evaluate the degree to which the data about risks is useful for risk management. It involves examining the degree to which the risk is understood and the accuracy, quality, reliability, and integrity of the data about the risk PMBOK (2013). In addition the book explains that the use of low-quality risk data may lead to a qualitative risk analysis of little use to the project. If data quality is unacceptable, it may be necessary to gather better data. Often, the collection of information about risks is difficult, and consumes more time and resources than originally planned.
- **Risk categorization** is a way of systematizing project threats. Risk to the project can be categorized by their sources, the area of project affected, project phase and common root causes. In order to identify areas of the project that are most exposed to those risks we can use risk break down structure (RBS) or work break down structure (WBS); and their role is to develop effective risk response. This technique helps determine work packages, activities, project phases or even roles in the project, which can lead to the development of effective risk responses PMBOK(2013) and Mhetre *et al.*(2016).

- **Risk Urgency Assessment** risks requiring near-term responses may be considered more urgent to address. Indicators of priority may include probability of detecting the risk, time to affect a risk response, symptoms and warning signs, and the risk rating. The role of risk urgency assessment is to prioritize risks according to how quick response they require PMBOK(2013) and Mhetre *et al.*(2016).
- **Expert judgment** is required to assess the probability and impact of each risk to determine its location in the matrix. Experts generally are those having experience with similar, recent projects. Gathering expert judgment is often accomplished with the use of risk facilitation workshops or interviews. The experts' bias should be taken into account in this process PMBOK(2013).

2.6.3.3 OUTPUTS OF QUALITATIVE RISK ANALYSES

The outputs for this analysis is project documents updates; PMBOK (2013) includes.

- **Risk register updates:-**As new information becomes available through the qualitative risk assessment, the risk register is updated. Updates to the risk register may include assessments of probability and impacts for each risk, risk ranking or scores, risk urgency information or risk categorization, and a watch list for low probability risks or risks requiring further analysis.
- **Assumptions log updates:-**As new information becomes available through the qualitative risk assessment, assumptions could change. The assumptions log needs to be revisited to accommodate this new information. Assumptions may be incorporated into the project scope statement or in a separate assumptions log.
- **Prioritized list:-**Listing of risks in priority order or in priority groups like high, moderate; and low PMI (2009).

2.6.4 PERFORM QUANTITATIVE RISK ANALYSIS

It is the process of numerically analyzing the effect of identified risks on overall project objectives. The key benefit of this process is that it produces quantitative risk information to support decision making in order to reduce project uncertainty PMBOK (2013). According to Smith *et al.*(2006) the probability of a risk arising is a key factor in the decision making process. Possible consequences of risk occurring are defined and quantified in terms of:

- **increased cost** that is additional cost above the estimate of the final cost of the project;

- **increased time** that is additional time beyond the completion date of the project through delays in construction;
- **reduced quality and performance** that is the extent to which the project would fail to meet the user performance based on quality, standards and specification.

These may be analyzed using sensitivity and probability analysis.

Perform Quantitative Risk Analysis generally follows the Perform Qualitative Risk Analysis process. In some cases, it may not be possible to execute the Perform Quantitative Risk Analysis process due to lack of sufficient data to develop appropriate models. The project manager should exercise expert judgment to determine the need for and the viability of quantitative risk analysis. The availability of time and budget, and the need for qualitative or quantitative statements about risk and impacts, will determine which method(s) to use on any particular project PMBOK (2013).Quantitative Risk Analysis numerically estimates the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impacts of all identified and quantified risks WSDOT (2014).

2.6.4.1 INPUTS FOR QUANTITATIVE RISK ANALYSIS

The inputs for quantitative risk analysis are indicated in the following Table:

Table 2.10 Quantitative risk analysis input

Nº	**Inputs**	**Scope**
1	**Risk Management Plan**	As describe previously in RMP outputs provides guidelines, methods, and tools to be used in quantitative risk analysis.
2	**Cost Management Plan**	The cost management plan provides guidelines on establishing and managing risk reserves.
3	**Schedule Management Plan**	The schedule management plan provides guidelines on establishing and managing risk reserves.
4	**Risk Register**	As describe previously in identify risk outputs The risk register is used as a reference point for performing quantitative risk analysis.

5	**Enterprise Environmental Factors**	may provide insight and context to the risk analysis, such as: • Industry studies of similar projects by risk specialists, and • Risk databases that may be available from industry or proprietary sources.
6	**Organizational Process Assets**	The organizational process assets that can influence the Perform Quantitative Risk Analysis process include information from prior, similar completed projects.

adapted PMBOK; (2013).

2.6.4.2 TOOLS AND TECHNIQUES FOR QUANTITATIVE RISK ANALYSIS

According to WSDOT (2014)in order to fully understand our projects, we must determine what we know and what we do not know about a project. Just as important is to **devote some energy and resources to assess what is not known** and/or is uncertain about a project. One tool for accomplishing this is intentional, thoughtful, and deliberate project risk management, as part of an overall Project Management Plan. The tools and techniques of quantitative risk analysis are presented in the following Table:

Table 2.11 Tools and Techniques of quantitative analysis

No	Tools and Techniques	Scope
1	**Data gathering and representation techniques**	
	1.1 Interviewing/ surveys (questionnaires)	-draw on experience and historical data to quantify the probability and impact of risks on project objectives. The information needed depends upon the type of probability distributions that will be used. - Can be formal or informal settings, such as smaller group meetings or larger formal workshops.
	1.2 Probability distributions (beta or Triangulation distribution)	which are used extensively in modeling and simulation, represent the uncertainty in values such as durations of schedule activities and costs of project components. Discrete distributions can be used to represent uncertain events, such as the outcome of a test or a possible scenario in a decision tree.

2	**Quantitative risk analysis and modeling techniques**	
	2.1 Sensitivity analysis **(the tornado diagram)**	helps to determine which risks have the most potential impact on the project. It helps to understand how the variations in project's objectives correlate with variations in different uncertainties. Conversely, it examines the extent to which the uncertainty of each project element affects the objective being studied when all other uncertain elements are held at their baseline values.
	2.2 Expected monetary value analysis **(a decision tree analysis)**	is a statistical concept that calculates the average outcome when the future includes scenarios that may or may not happen (i.e., analysis under uncertainty). The EMV of opportunities are generally expressed as positive values, while those of threats are expressed as negative values.
	2.3 Modeling and simulation **(Monte Carlo simulation)**	uses a model that translates the specified detailed uncertainties of the project into their potential impact on project objectives. In a simulation, the project model is computed many times (iterated), with the input values (e.g., cost estimates or activity durations) chosen at random for each iteration from the probability distributions of these variables. It uses three point estimates like most likely, worst case and best case duration for each task in time management.
3	**Expert Judgment (ideally using experts with relevant, recent experience)**	-is required to identify potential cost and schedule impacts, to evaluate probability, and to define inputs such as probability distributions into the tools. - also comes into play in the interpretation of the data. Experts should be able to identify the weaknesses of the tools as well as their strengths. Experts may determine when a specific tool may or may not be more appropriate given the organization's capabilities and culture.

adapted from PMBOK (2013), WSDOT (2014) , Mahendra *et al.*(2013) and Mheter *et al.*(2016).

2.6.4.3 OUT PUTS OF QUANTITATIVE RISK ANALYSIS

The out puts of this analysis are risk register and informal work shop meeting: Paul (2015), WSDOT (2014) and PMBOK(2013).

Risk register

The risk register begins during risk identification and is further developed during analysis. The risk register is a key component of the Project Management Plan WSDOT (2014). It is further updated to include a quantitative risk report detailing contingency approaches, out puts, and recommendations Paul (2015). Updates include the following:

- **Prioritized list of quantified risks:** Those risks that have the most significant impact (threats or opportunities) to project objectives WSDOT (2014) and PMBOK (2013). These include the risks that may have the greatest effect on cost contingency and those that are most likely to influence the critical path PMBOK (2013). These risks may be evaluated through tornado diagrams, expected values, decision trees.
- **Probabilistic analysis of the project:** According to WSDOT(2014) and PMBOK (2013)estimates are made of potential project schedule and cost outcomes listing the possible completion dates and costs with their associated confidence levels. This output, often expressed as a cumulative frequency distribution, is used with stakeholder risk tolerances to permit quantification of the cost and time contingency reserves. Such contingency reserves are needed to bring the risk of overrunning stated project objectives to a level acceptable to the organization PMBOK (2013).
- **Probability of achieving cost and time objectives.** With the risks facing the project, the probability of achieving project objectives under the current plan can be estimated using quantitative risk analysis results PMBOK(2013).
- **Trends in quantitative risk analysis results.** As the analysis is repeated, a trend may become apparent that leads to conclusions affecting risk responses. Organizational historical information on project schedule, cost, quality, and performance should reflect new insights gained through the Perform Quantitative Risk Analysis process. Such history may take the form of a quantitative risk analysis report. This report may be separate from, or linked to, the risk register WSDOT (2014) and PMBOK (2013).

INFORMAL WORK SHOP MEETING

According to WSDOT(2014) for smaller projects, it may be sufficient to have an informal workshop composed of the project team and/or key project team members and other

participants (such as specialty groups involved with critical items). WSDOT further states that risk management is ongoing and iterative; periodically, workshop members can regroup to evaluate the project and associated uncertainty and risks. Workshops typically occur for a project every 12 to 24 months or at key project milestones.

2.6.5 PLAN RISK RESPONSES

Once risks have been identified and their significance has been assessed, the next phase of the typical risk process seeks to formulate realistic and effective responses. Responses must be appropriate, affordable, and achievable, taking the significance of each risk into account Hillson (2004).

According to PMI (2009) and PMBOK (2013);it is the process of developing options and actions to enhance opportunities and to reduce threats to project objectives. The key benefit of this process is that it addresses the risks by their priority, inserting resources and activities into the budget, schedule and project management plan as needed.

This process follows the perform quantitative risk analysis process (if used). Each risk response requires an understanding of the mechanism by which it will address the risk. Risk responses should be appropriate for the significance of the risk, cost-effective in meeting the challenge, realistic within the project context, agreed upon by all parties involved, and owned by a responsible person. Selecting the optimum risk response from several options is often required PMBOK (2013).The project manager should develop risk response strategies for individual risks, and project level risks. The affected stakeholders should be involved in determining the strategies. Once the strategies have been selected, they need to be agreed up on by the entity (individual) that approves those strategies PMI (2009).

2.6.5.1 RISK RESPONSE INPUTS

As stated on PMBOK (2013) the main input is the updated risk register where are listed the all known risks with information about them. Other inputs are the further information about the project, the company and the external conditions. Accordingly, risk response inputs are shown in the following Table:

Table 2.12 Risk response input

No	Inputs	Scope
1	**Risk management**	include roles and responsibilities, risk analysis definitions, timing for reviews (and for eliminating risks from review),

	plan	and risk thresholds for low, moderate, and high risks. Risk thresholds help identify those risks for which specific responses are needed.
2	**Risk register**	refers to identified risks, root causes of risks, lists of potential responses, risk owners, symptoms and warning signs, the relative rating or priority list of project risks, risks requiring responses in the near term, risks for additional analysis and response, trends in qualitative analysis results, and a watch list, which is a list of low priority risks within the risk register.

adapted from PMBOK (2013).

2.6.5.2 RISK RESPONSE TOOLS AND TECHNIQUES

According to WSDOT (2014) following identification and analysis of project risks, Project Managers and project teams must act. Accountability demands a response to identified project risks. Focus should be directed toward risks of most significance. Effective project risk management can shift the odds (chances/probability) in favor of project success. Kerzner (2009) and WSDOT (2014) described actions in response to risks in to three which deal with treat and opportunity and one which deals with both as shown in the following Table.

Table 2.13 Summary of response options for risks (treaties) and opportunities

Type of Response	**Use for Treat or Opportunity**	**Description**
Avoidance	Treat	Eliminate risk by accepting another alternative, changing the design, or changing a requirement. Can affect the probability and/or impact.
Mitigation (control)	Treat	Reduce probability and/or impact through active measures.
Transfer	Treat	Risk Reduce probability and/or impact by transferring ownership of all or part of the risk to another party, or by

		redesign across hardware/software or other interfaces, etc.
Exploit	Opportunity	Take advantage of opportunities.
Share	Opportunity	Share with another party who can increase the probability and/or impact of opportunities.
Enhance	Opportunity	Increase probability and/or impact of opportunity.
Acceptance	Treat and Opportunity	Adopt a wait-and-see attitude and take action when triggers are met. Budget, schedule, and other resources must be held in reserve in case the risk occurs or opportunity is selected.

adapted from Kerzner (2009) and WSDOT(2014).

A strategic approach to risk response planning is adopted in many risk management processes, with a set of high-level strategies identified. The aim is to select the most appropriate strategy for each risk, depending on its nature, severity, and manageability, and then to design specific actions to implement the chosen strategy Hillison (2004). Accordingly, as stated in PMBOK (2013) typical response strategies available during the risk response planning phase include: strategies for negative risks or treats, strategies for positive risks or opportunities, contingent response strategies and expert judgment.

Strategies for negative risks or treats

Three strategies, which typically deal with threats or risks that may have negative impacts on project objectives if they occur are: avoid, transfer, and mitigate. The fourth strategy, accept, can be used for negative risks or threats as well as positive risks or opportunities. Each of these risk response strategies have varied and unique influence on the risk condition. These strategies should be chosen to match the risk's probability and impact on the project's overall objectives PMBOK (2013).

- **AVOID (threats)** action taken to ensure the probability or impact of a threat is eliminated WSDOT (2014). Avoidance actions include: changing the project scope to eliminate a threat; clarifying requirements, obtaining information, improving communication, or acquiring expertise PMBOK (2013), WSDOT (2014) and Paul (2015).The project manager says, "I will not accept this option because of the potentially unfavorable results. I will either change the design to preclude (prevent) the issue or requirements that lead to the issue." Kerzner (2009).

  According to Hillson (2004) the avoid response seeks to eliminate the treat, aims to reduce probability of occurrence to zero and remove uncertainty. There are two types

of action: The first one removing the uncertainty over whether or not it might be achieved by ensuring that the potential opportunity is definitely locked into the project, rather than leaving it to chance or the second involve doing the project in a different way to allow the opportunity to be achieved while still meeting the project objectives.

- **TRANSFER (threats)** action to allocate ownership for more effective management of a threat WSDOT (2014). Transferring a threat does not eliminate it the threat still exists; however, it is owned and managed by another party. Transferring risk can be an effective way to deal with financial risk exposure. Transferring project risk involves payment of a risk premium to the party taking the risk; for example, insurance, performance bonds, or warranties. Contracts may be used to transfer specified risks to another party PMBOK (2013), WSDOT (2014) and Paul (2015).The project manager says, "I will share this risk with others through insurance or a warranty or transfer the entire risk to them. I may also consider partitioning the risk across hardware and/or software interfaces or using other approaches that share the risk."Kerzner (2009).

  Transferring risk involves finding another party who is willing to take responsibility for its management, and who will bear the liability of the risk should it occur. The aim is to ensure that the risk is owned and managed by the party best able to deal with it effectively. Risk transfer usually involves payment of a premium, and the cost-effectiveness of this must be considered when deciding whether to adopt a transfer strategy Hillson (2004).

- **MITIGATE – or reduce (threats)** action taken to reduce the probability and/or impact of a threat WSDOT (2014). Risk mitigation implies a reduction in the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action is often more effective to repair than trying to repair the damage after the risk has occurred. Examples of mitigation strategies include: adopting less complex processes, conducting more tests and/or field investigations, developing a prototype. Measures to address impacts include: targeting linkages that determine the severity, such as designing redundancy into a subsystem, may reduce the impact from a failure of the original component PMBOK (2013), WSDOT (2014) and Paul (2015).The project manager says, "I will take the necessary measures required to control this risk

by continuously reevaluating it and developing contingency plans or fall-back positions. I will do what is expected."Kerzner (2009).

Mitigation or reduction responses aim to modify the size of the risk, by tackling its probability of occurrence and/or its severity of impact. Making a risk less likely or less severe reduces the overall risk exposure of the project. Preventive actions can be designed to reduce the likelihood of a risk occurring, or steps can be taken in advance to protect the project against the effect of a risk should it occur Hillson (2004).

- **ACCEPT** Action taken to document acceptance of the risk WSDOT (2014). Some threats will remain after avoidance, transfer, or mitigation responses have been taken, and others will be identified that cannot be tackled proactively within the scope of the project or the capability of the organization. These are known as residual risks. Accepting a risk involves either actively making plans for actions to be taken if the risk occurs (i.e., contingency), or passively doing nothing where that is considered appropriate or where no other cost-effective or feasible option exists Hillson (2004).The project manager says, "I know the risk exists and am aware of the possible consequences. I am willing to wait and see what happens. I accept the risk should it occur."Kerzner (2009).

  Ultimately, it is not possible to eliminate all threats or take advantage of all opportunities PMBOK (2013), WSDOT (2014) and Paul (2015). In some cases, in some industries, a contingency reserve, including amount of time ,money, or resources are established to deal with the aggregate residual risk that has been accepted; we can document them and at least provide awareness that these exist and have been identified; Hillson (2004) term this "passive acceptance." In some cases, in some industries, a contingency reserve, including amount of time ,money, or resources are established to deal with the aggregate residual risk that has been accepted; Hillson (2004) term this "active acceptance."

Strategies for Positive Risks or Opportunities

Three of the four responses are suggested to deal with risks with potentially positive impacts on project objectives. The fourth strategy, accept, can be used for negative risks or threats as well as positive risks or opportunities. These strategies, described below, are to exploit, share, enhance, and accept PMBOK (2013).

- **EXPLOIT** action taken to ensure the benefit of an opportunity is realized WSDOT (2014). The opposite of avoid, this strategy is to ensure a positive impact, or realize an opportunity. Take action to make the opportunity happen; such response actions include: assigning more talented resources to a project to reduce time to completion and/or providing better quality than originally planned PMBOK (2013), WSDOT (2014) and Paul (2015).The project manager says, "This is an opportunity. How can we make the most of it? Will assigning more talented resources allow us to get to the marketplace quicker?"Kerzner (2009).

  The aim of this risk response strategy is to eliminate the uncertainty associated with a particular upside risk. An opportunity is defined as a risk event that, if it occurs, will have a positive effect on achievement of project objectives. The goal of the exploit strategy for opportunities is to raise the probability to 100% the uncertainty is removed. Exploit is the most aggressive of the response strategies and should be reserved for those "golden opportunities" with high probability and impacts Hillson (2014).
- **ENHANCE (**Action to enhance opportunity) this response modifies the "size" of an opportunity by increasing probability and/or impact. Seeking to facilitate or strengthen the cause of the opportunity, and proactively targeting and reinforcing its trigger conditions. Impact drivers can also be targeted, seeking to increase the project's susceptibility (weakness) to the opportunity PMBOK (2013), WSDOT (2014) and Paul (2015). The project manager says, "This is an opportunity. What can we do to increase the probability of occurrence of the opportunity, such as by using more aggressive advertising?"Kerzner (2009). This response aims to modify the "size" of the risk to make it more acceptable. Opportunities can be enhanced by increasing probability and/or impact, by identifying and maximizing key risk drivers. If the probability can be increased to 100%, this is effectively an exploit response Hillson (2014).
- **SHARE (opportunities)** action to share with a third party; enhance/ exploit opportunity WSDOT (2014). Sharing a positive risk involves allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project. Examples of sharing actions include forming risk-sharing partnerships, teams, or joint ventures, which can be established with the express purpose of managing

opportunities PMBOK (2013), WSDOT (2014) and Paul (2015). The project manager says, “This is an opportunity, but we cannot maximize the benefits alone. We should consider sharing the opportunity with a partner.”Kerzner (2009).

Allocating risk ownership for an opportunity to another party who is best able to handle it, in terms of maximizing probability of occurrence and increasing potential benefits if it does occur. Transferring threats and sharing opportunities are similar in that a third party is used; those to whom threats are transferred take on the liability and those to whom opportunities are allocated should also be allowed to share in the potential benefits Hillson (2004).

- **ACCEPT (opportunities)** action taken to document acceptance of the risk WSDOT (2014). Accepting an opportunity is being willing to take advantage of the opportunity if it arises, but not actively pursuing it PMBOK (2013). The project manager says, “I know an opportunity exists and am aware of the possible benefits. I am willing to wait and see what happens. I accept the opportunity should it occur.”Kerzner (2009).

Contingent Response strategies

According to PMBOK (2013) some responses are designed for use only if certain events occur. For some risks, it is appropriate for the project team to make a response plan that will only be executed under certain predefined conditions, if it is believed that there will be sufficient warning to implement the plan. This book further states that events that trigger the contingency response, such as missing intermediate milestones or gaining higher priority with a supplier, should be defined and tracked. Risk responses identified using this technique are often called contingency plans or fallback plans and include identified triggering events that set the plans in effect.

Expert Judgment

Expert judgment is input from knowledgeable parties pertaining to the actions to be taken on a specific and defined risk. Expertise may be provided by any group or person with specialized education, knowledge, skill, experience, or training in establishing risk responses PMBOK (2013).

2.6.5.3 RESPONSE PLAN OUTPUTS

Based on PMBOK (2013) the response plan outputs are project plan updates and Project documents updates.

Project plan updates: Elements of the project management plan that may be up dated as a result of carrying out this process include, but are not limited to:

- **Schedule management plan:** This may include changes in tolerance or behavior related to resource loading and leveling, as well as updates to the schedule strategy.
- **Cost management plan:** This may include changes in tolerance or behavior related to cost accounting, tracking, and reports, as well as updates to the budget strategy and how contingency reserves are consumed.
- **Quality management plan:** This may include changes in tolerance or behavior related to requirements, quality assurance, or quality control, as well as updates to the requirements documentation.
- P**rocurement management plan:** may be updated to reflect changes in strategy, such as alterations in the make-or-buy decision or contract type(s) driven by the risk responses.
- **Human resource management plan:** This may include changes in tolerance or behavior related to staff allocation, as well as updates to the resource loading.
- **Scope baseline:** Because of new, modified or omitted work generated by the risk responses, the scope baseline may be updated to reflect those changes.
- **Schedule baseline:** Because of new work (or omitted work) generated by the risk responses, the schedule baseline may be updated to reflect those changes.
- **Cost baseline:** Because of new work (or omitted work) generated by the risk responses, the cost baseline may be updated to reflect those changes.

Project Documents Updates: In the Plan Risk Responses process, several project documents are updated as needed. For example, when appropriate risk responses are chosen and agreed upon, they are included in the risk register. The risk register should be written to a level of detail that corresponds with the priority ranking and the planned response. Often, the high and moderate risks are addressed in detail PMBOK (2013).

According to Hillson (2014) once the responses have been developed, it is important to select the right owner for each risk response. This is defined as " the party best placed to manage the risk effectively." Some risks could be to the customer, client, or users. Others

may be best placed with suppliers, contractors, or subcontractors who possess specialist expertise or have responsibility for particular elements of the project. The key consideration is to determine who can make a difference to the risk. This author further states that when allocating owners, it is important to build and retain cooperation and consensus, seeking to avoid contractual power struggle or the placing of blame. The necessary resources should be provided to enable the response to be implemented, and the project manager should monitor the status of risk responses regularly, not abdicating responsibility to the response owner.

2.6.6 CONTROL RISKS

According to Office of PMPI (2003) and PMBOK (2013) it is the process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the project. The key benefit of this process is that it improves efficiency of the risk approach throughout the project life cycle to continuously optimize risk responses PMBOK (2013).The list of project risks changes as the project matures, new risks develop, or anticipated risks disappear OPMPI (2003). Similarly, as we continue through project development, the project risk profile will change. As we successfully respond to risks and our project knowledge increases, our risk exposure will diminish WSDOT (2014).According to PMBOK (2013) planned risk responses that are included in the risk register are executed during the life cycle of the project, but the project work should be continuously monitored for new, changing, and outdated risks.

Control Risks can involve choosing alternative strategies, executing a contingency or fallback plan, taking corrective action, and modifying the project management plan. The risk response owner reports periodically to the project manager on the effectiveness of the plan, any unanticipated effects, and any correction needed to handle the risk appropriately. Control Risks also includes updating the organizational process assets, including project lessons learned databases and risk management templates, for the benefit of future projects PMBOK (2013).

2.6.6.1 INPUTS OF RISK CONTROL

According to PMBOK (2013)The inputs of risk control are Project Management Plan, Risk register, work performance data and work performance report. This book further explained that, T**he project management plan,** which includes the risk management plan, provides guidance for risk monitoring and controlling. **The risk register** has key inputs that include identified risks and risk owners, agreed-upon risk responses, control actions for assessing the

effectiveness of response plans, risk responses, specific implementation actions, symptoms and warning signs of risk, residual and secondary risks, a watch list of low-priority risks, and the time and cost contingency reserves. The watch list is within the risk register and provides a list of low-priority risks. **Work performance data** related to various performance results possibly impacted by risks includes, but is not limited to: Deliverable status, Schedule progress, and Costs incurred. **Work performance reports** take information from performance measurements and analyze it to provide project work performance information including variance analysis, earned value data, and forecasting data. These data points could be impactful in controlling performance related risks.

2.6.6.2 TOOLS AND TECHNIQUES OF RISK CONTROL

As stated in PMBOK (2013), the tools and techniques of monitor and control risk process are : risk assessment, Risk audit, Variance and trend analysis, Technical performance measurement, reserve analysis and statues meetings.

- **Risk reassessment** :-The project should be controlled throughout the life cycle; the reassessment usually identifies new risks, revaluate the current risks and close the outdated.
- **Risk audits :-** This is a method of examining and documenting the effectiveness of risk responses in dealing with known risks and their root causes, as well as the effectiveness of the risk management process.
- **Variance and trend analysis:-**Is a method used for monitoring overall project performance. variance analysis a controlling process to compare the planned results to the actual results. For the purposes of controlling risks, trends in the project's execution should be reviewed using performance information.
- **Technical performance measurement:-**This method is used to compare technical accomplishments during project execution to the schedule of technical achievement. Deviation, such as demonstrating more or less functionality than planned at a milestone, can help to forecast the degree of success in achieving the project's scope.
- **Reserve analysis:-**This analysis compares the amount of contingency reserves remaining to the amount of risk remaining at any time in the project.
- **Statues meetings:-**It is a frequent discussions about risk that have been identified, their priority, and difficulty of response.

2.6.6.3 OUTPUTS OF RISK CONTROL

As stated on PMBOK (2013) the outputs of risk control are updated documents, such as:

- **Project management plan** with approved changes**,**
- **Work performance information**:- to provide a mechanism to communicate and support project decision making.
- **Change requests** with recommended corrective or prevention actions.
- **Project Documents Updates;** outcomes of risk reassessments, risk audits, and periodic risk reviews and actual outcomes of the project's risks and of the risk responses.
- **The organizational process assets** include, but are not limited to: templates for the risk management plan, including the probability and impact matrix and risk register, risk breakdown structure, and lessons learned from the project risk management activities.

2.7 RISK CLASSIFICATION

Risk classification is a significant step in the risk management process, as it attempts to structure the devices risks affecting a construction project. In order to manage risks effectively, many approaches have been suggested in literature for classifying risk. According to Chitkara (2003) classified depending upon the nature of environment in to two categories manageable and non manageable. Cooper *et al.* (2005) grouped it in to two internal risk, which fall with the control of the clients, consultants and contractors and external risk, which include risk elements that are not in the control of key stake holders. Similarly, Eshan *et al.*(2010) categorized in to technical, logistical, management related , environmental, financial. Mhetre *et al*.(2016) categorized in to technical, construction, physical, organizational, financial, environmental and socio-political risks.

The Table 2.14 provides different researchers risk classification from different country in relation with construction industries, project risk, project objectives, building projects and so on.

Table 2.14 Risk classification compiled by the researcher.

No	Authors	Type of risk	Risk categorization/ Classification	Number of risk factors identified
1	Ehsan *et al*., (2010)	Risk associated with the construction industry	Natural, Political and social, economic and legal, behaviors Technical, Logistical, Management related, Environmental, Financial, and socio political risks	29
2	Mhetre (2016)	Risk associated with construction industry	Technical, construction, physical, organizational, financial, socio-political, and Environmental risks	>37
3	Shuibo Z .*et al.*(2006)	Project risk	Under project risks: Natural, Political and social, economic and legal, behaviors	>19
4	Zavadskas *et al.*(2010)	Risk in construction	Under External, Project and internal group: political, economic, social, weather, Cost, time, quality, technological, construction, site, project member, resource, document and information respectively.	-
5	Mahendra *et al.* (2013)	Risk associated with the construction industry	Technical , construction , physical, organizational, Financial, Socio political, and environmental risks	37
6	Kerzner (2009)	Risk on construction projects	External-Unpredictable, External-predictable, Internal (non	19

			technical), technical and Legal.	
7	Augustine *et al.* (2013)	Establishing of the Risk Management Index	Financial, Management, Market, Technical , Legal, construction, political, and environmental risks	34
8	AbdKarim *et al.* (2012)	Building construction project	Physical, environmental, Design, Logistic, Financial, Legal, construction, political, Management risks	>52
9	Zou *et al.* (2007)	Risk influencing project objectives(cost, time, quality, safety and environment.	Client, Designer, contractor, subcontractor/supplier, government agencies, and external issues	Out of 85 risk factors identified 25.
10	Mubin and Mubin (2008)	Risk associated with pipe line production	political, socio economical, organizational, investment, technological, security, Natural and climate, and environmental risks	32
11	Renuka *et al.* (2014)	Risk Sources affecting the Project Success(Non Engineering and Engineering source)	-client, design, project execution, construction management, Tendering and resource risks -country, political, environmental and geological, natural hazard, and statutory compliance risks	
12	Bodicha (2015) cited Al-Bahar, *1990*	Risk categorization in construction projects	act of God, physical, financial and economical, political and environmental, design, and construction related risks	32

13	Tsai and Yang (2010)	Project risk structure	natural phenomenon, economics/finance, politics/society, safety/environment, client, designer, and contractor risks	>63
14	Jayasudha and Vidivelli (2016)	Major risk in construction projects	Technical, Time, Construction, Design, Legal, Market, Management, Financial, Policy and Political, Environmental, Social, Safety, and Physical Risks	90
15	Enshassi *et al.*(2008)	Risk in Building Projects	Physical, Environmental, Design, Logistic, Financial, Legal, Construction, Political, and Management Risk.	44
16	Abd El-Karim *et al.*(2015)	Risk factors affecting construction projects based on site condition, resource, project parties, project features	Environmental, subsurface, site location, labour, equipment, material, owner, engineering and design, contractor, project manager, financial, political and schedule.	71

All steps in the process should be included to deal with risks, in order to implement the process of the project Mahandra *et al*. (2013). It need not be complicated nor require the collection of vast amounts of data. It is a matter of common sense, analysis, judgment, intuition, experience, gut feel and a willingness to operate a disciplined approach to one of the most critical features of any business or project in which risk is generated Flanagan and Norman (1993).

The riskier the activity is, the costlier will be the consequences in case a wrong decision is made. Proper evaluation and analysis of risks will help decide justification of costly measures to reduce the level of risk. It can also help to decide if sharing the risk with an insurance company is justified. Some risks such as natural disasters are virtually unavoidable and effect many people. In fact, all choices in life involve risks. Risks cannot be totally avoided but with proper management these can be minimized Eshan *et al.*(2010).

2.8 OBJECTIVE OF RISK MANAGEMENT

The main objective of risk management is to reduce uncertainty and thus improve decision making. The main types of uncertainty include error, imprecision, variability, vagueness, ambiguity and ignorance Baloi *et al*.(2003). Based on Goh and Abdul-Rahman (2013) successful risk management should convert uncertainty to risk and convert risk to opportunity. The project and organization would hence achieve more gains by maximizing opportunity, minimizing risk and reducing uncertainty. And thus encourages the project team to take appropriate measures to minimize: Adverse impacts to project scope, cost, and schedule and management by crisis OPMPI(2003). Based on Cooper *et el.*(2005) managing risk in projects is important to managers, project staff, end users and insurers. Of the benefits, it is applicable for all scales of projects and procurement activity. It can be applied at all stages in project cycle, from the earliest assessment of strategy to the supply, operation, maintenance and disposal of individual items facilities or assets.

2.9 FACTORS LIMITING THE APPLICATION OF RISK MANAGEMENT TECHNIQUE

Risk management techniques are essentially management techniques used to handle risky situations. According to Olamiwale (2014) cited Khalafallah and Azhar (2004) identified the following obstacles to the practical application of risk management in the construction industry:

- Deficiency in the knowledge of risk management techniques.
- Highly sophisticated techniques that are available are unwarranted compared with the size of the project.
- Reservations about the relevance of the available techniques to the construction industry.
- Most of the risks surfaced during the process of construction, and are quite subjective; therefore, they are best handled with experience from past contracts.
- Risk analyses of construction projects are rarely demanded by clients.
- Unavailability of quality data required poses a loss of confidence in risk management techniques.

2.10 TYPES OF PROJECT DELIVERY

As mentioned on previous **sections 2-4 and 4-5** one of the main objective of any procurement system/ delivery system is to secure an optimum level of risk transfer between the client and the contractor. In addition to this it establish the rights, duties, obligations, and responsibilities of the parties and to allocate risk. There are different type of project delivery system are mentioned in different literature such as: traditional (separated and cooperative approach), design-build (integrated and holistic approach), management oriented (packaged) Love *et al.* (1998), Rashid *et al.* (2006), Osipova (2008) and Davis *et al.* (2008). And included collaborative (relational) system Rashid *et al.* (2006), Osipova (2008) and Davis *et al*. (2008). However, in this section only the three project delivery methods: DBB, DB, and construction management (CM) are discussed.

As stated in Jackson (2004) these three project delivery methods differ in five fundamental ways:

- The number of contracts the owner executes;
- The relationship and roles of each party to the contract;
- The point at which the contractor gets involved in the project;
- The ability to overlap design and construction; and
- Who warrants the sufficiency of the plans and specifications. Regardless of the project delivery method chosen, the three primary players the owner, the owner, the designer (architect and/ or engineer), and the contractor are always involved.

2.10.1 DESIGN- BID- BUILD (DBB)

Design-bid-build is commonly referred to as the traditional method and the oldest form of delivery system. It can be defined as a project delivery strategy in which two separate organizations (design team and contractor) do carry out all project processes and are individually responsible directly to the client (see Figure 2.5 and 2.6) Jackson (2004) and Ghadamsi and Braimah (2010). This is a common method used and is found to suit clients of all types, particularly government institutions. Due to the feature of linear progression as shown in Figure below, this system provides better management for the client, but gives little considerations to the designing, information communication and construction delivery Tsai and Yang (2010).

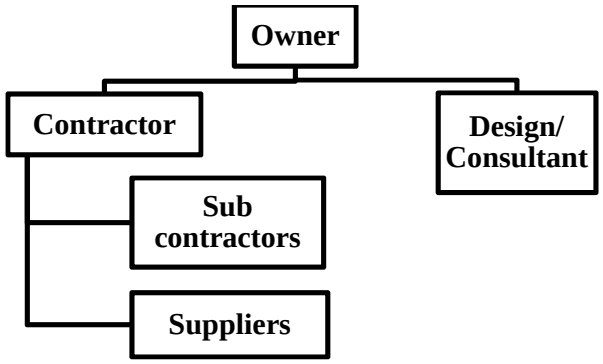


Figure 2.5 Project organization structure for DBB method.

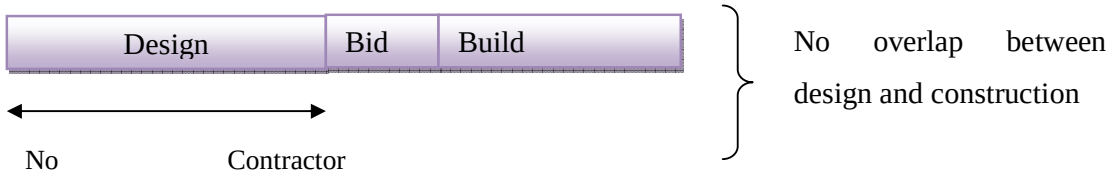


Figure 2.6 Design bid build linear approach.

According to Davis *et al*. (2008) the main advantages of using a DBB approach are:

- accountability due to a competitive selection;
- competitive equity as all tendering contractors bid on the same basis;
- design lead and the client is able to have a direct influence which can facilitate a high level of functionality and improve the quality in the overall design;
- price certainty at the award of the contract;
- variations (changes) to the contract are relatively easy to arrange and manage; and
- a tried and test method of procurement which the market is very familiar with.

And the main disadvantages of using this approach are:

- can be a timely process to produce the full contract documentation. Tenders documents from an incomplete design can be produced but can lead to less cost and time certainty, and may lead to disputes;
- overall project duration may be longer than other procurement methods as the strategy is sequential and construction cannot be commenced prior to the completion of the design;
- and no input into the design or planning of the project by the contractor as they are not appointed during the design stage.

Davis *et al*. (2008) further states citing Turner (1990) that this method should be used when:

- a program allows sufficient time;
- consultant design is warranted;
- a client wishes to appoint designers and contractors separately;
- price certainty is wanted (required) before the start of construction;
- product quality is required; and
- a balance of risk is to be placed between the client and constructor.

Ghadamsi and Braimah (2010) the circumstances in which this method is generally considered appropriate include the following:

- The service of a designer has already been procured;
- The designer is experienced enough to oversee both the design and construction;
- The design is substantially complete by the time the contractor is selected;
- Contractor is selected on the basis of price with a general acceptance that the price may be wrong;
- It is important for client to use a contract form with fair and familiar distribution of risk;
- When neither the employer or his advisers raise this as an issue;
- Full tender documentation exist to ensure price certainty;
- The bill of quantities can be used for valuing variations;
- Client desires competitive tendering;
- Scope of work is clear and well defined to facilitate detailed design.

2.10.2 DESIGN-BUILD (DB)

It is classified as one of the integrated form of procurement method, whereby the client provides

his/her requirements and needs for the specified project and signed contract with only one organization namely the contractor. This organization is responsible for the design, supervision and construction services of the project as shown in Figure 2.7 Jackson (2004) and Ghadamsi and Braimah (2010). The popularity of DB contracts has increased in recent years, because a single point of responsibility is attractive to clients Osipova (2008). In addition to this one of the greatest advantages to this is the possibility for early contractor involvement (see Figure 2.8). Under this method, all of the team players (the designers, the contractors, the material suppliers and manufacturers) have an opportunity to be in continuous communication throughout the project Jackson (2004).

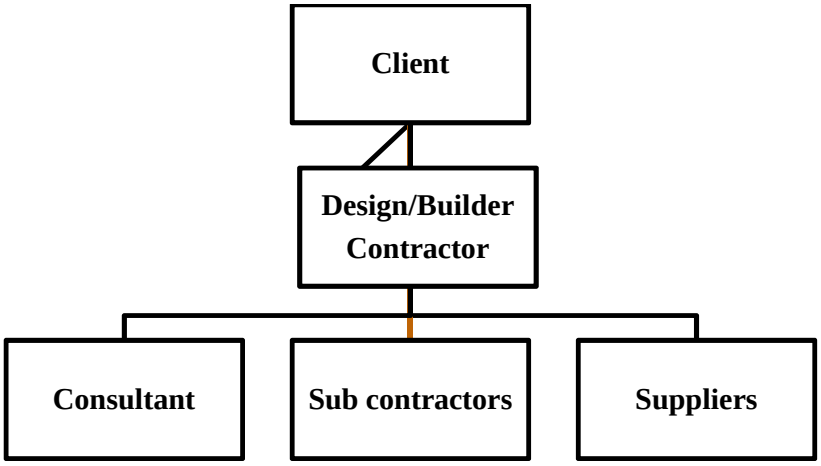
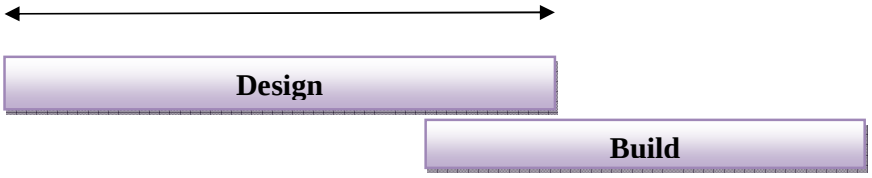


Figure 2.7 project organization structure for DB procurement method.



Overlapped design and construction

Figure 2.8 Design build integrated approach.

According to Davis *et al.* (2008) the main advantages of using a DB approach are:

- client has to deal with one firm and reduces the need to commit resources and time to contracting designers and contractors separately;

- price certainty is obtained before construction commences as client's requirements are specified and changes are not introduced;
- use of a guaranteed maximum price with a savings option split can stimulate innovation and reduce time and cost;
- overlap of design and construction activities can reduce project time; and
- improved constructability due to contractor's input into the design.

And the main disadvantages of using this approach are:

- difficulties can be experienced by clients in preparing an adequate and sufficiently comprehensive brief;
- client changes to project scope can be expensive;
- difficulty in comparing bids since each design will be different, project program will vary between bidders, and prices for the project will be different for each design;
- client is required to commit to a concept design at an early stage and often before the detailed designs are complete; and
- design liability is limited to the standard contracts that are available.

Davis *et al*. (2008) further states citing Turner (1990) that this method should be used when:

- building is functional rather than prestigious;
- building is simple rather than complex, is not highly serviced and does not require technical innovation;
- brief for scope design is likely to change;
- program can be accelerated by overlapping design and construction activities; and
- single organization is required to take responsibility and risk for design and construction.

Ghadamsi and Braimah (2010) the circumstances in which this method is generally considered appropriate include the following :

- Client not familiar with the construction process;
- Project is technically complexity;
- There is a low likelihood of variations to the project;
- Client desires a single point of responsibility;
- The employer desires a quick start to work on site;
- Client desires to prioritize either time, quality, price or value for money etc.

- Client desires an opportunity for effective direct communication/interaction with contractors; and
- Client desires for an integration of the design and construction process.

2.10.3 CONSTRUCTION MANAGEMENT (CM)

Under this method, construction management services are provided to the owner independent of the construction work itself (Figure 2.9) Jackson (2004). The management contractor is selected after a careful selection process and is paid a management fee to professionally manage, develop a program and coordinate the design and construction activities, and to facilitate collaboration to improve the project's constructability Davis *et al*. (2008) . As stated by Jackson (2004) there are two options for the owner to consider under this method. This are Agency CM and at risk CM.

- **Agency CM** as a fee-based service in which the construction manager is responsible exclusively to the owner and acts in the owner's best interests at every stage of the project. In this case, the construction manager offers advice uncolored by any conflicting interest because he or she does not perform any of the actual construction work and is not financially at risk for it.
- **At-risk CM** project delivery method as an option that entails a commitment by the construction manager to deliver the project within a guaranteed maximum price. The construction manager acts as consultant to the owner in the development and design phases, but does the work of a general contractor during the construction phase.

The author further states that the former arrangement involves three contracts: one between the owner and the designer, one between the owner and the contractor, and one between the owner and the construction manager. The owner hires a designer and a contractor exactly as described under the design-bid-build scenario. In addition, the owner also contracts with a third party, a construction management firm that provides construction management functions but as an independent agent or representative of the owner. In the latter scenario, there are only two contracts, one between the owner and designer and one between the owner and the at-risk CM. Although this might seem like a tricky relationship to manage, owners are comfortable with it because the at-risk CM is also responsible for performing the construction and carries financial liability for bringing the project in on time and within budget. By contrast, under the agency CM model, the construction manager is not at risk for the budget, the schedule, or the performance of the work.

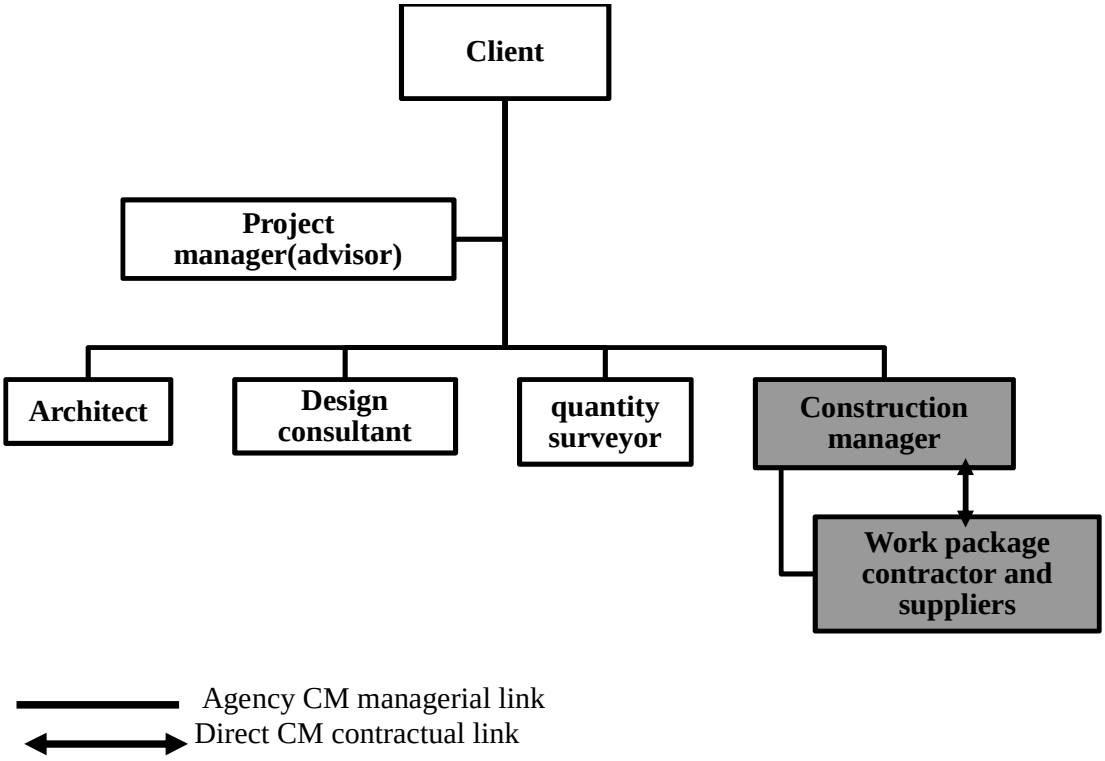


Figure 2.9 CM management oriented.

A number of advantages have been identified that can be offered by the CM approach Walker *et al.* (1999) cited by Davis *et al.* (2008).This is summarized as follows:

- Reduced confrontation between the design teams and the team responsible for supervising construction;
- early involvement of construction management expertise;
- overlap of design and construction;
- increased competition for construction work on large projects due to work packaging and splitting the construction activities into more digestible 'large piece';
- more even development of documentation;
- fewer contract variations;
- no need for nominated trade contractors; and
- public accountability

In addition to this Davis *et al*. (2008) included the main advantages of using a CM approach. These are:

- the client deals with only one firm, which enables improved coordination and collaboration between designers and constructors;
- potential for time savings for the overall project as design and construction activities are overlapped;
- improved constructability through constructor input into the design;
- roles, risks and responsibilities for all parties are clear; and
- flexibility for changes in design.

Further to this the main disadvantages of using this approach are:

- price certainty is not achieved until the final works package has been let;
- informed and proactive client is required;
- poor price certainty;
- close time and information control required; and
- client must provide a good quality brief to the design team as the design will not be complete until resources have been committed to the project.

2.11 SUGGESTED METHODOLOGY FOR SYSTEMATICALLY ADDRESSING RISK ALLOCATION

According to Dutta (2014), one of the major risks faced by construction industry is contract risk. Since, it is difficult to remove all potential risks in a construction project, thus it is crucial to allocate risks among parties in the project through a contract. If not, project performance in terms of cost, quality and time is often affected. Moreover, disputes and misunderstandings are often the end result between clients and contractors when the distribution of risk is not well allocated. Therefore, proper risk allocations in construction contracts can help reduce such impacts and achieve management efficiency. Accordingly, Groton and Smith (2010) suggested the following examples of risk in the tables below (Table 2.15, 2.16 and 2.17) during the course of negotiating and drafting a construction contract; indicating to whom they are to be allocated and why, and how they are allocated and mitigated. In addition based on construction contract risk factors mentioned on Table 2-4 the researcher presented in the **appendix IV** by referring FIDIC 1999 and PPPAA 2011common allocation of risk in building construction contract for the parties having an effect on building contractors.

Table 2.15 Allocating Outside Influence-Type Risks.

Allocating Outside Influence-Type Risks		
Risk	**To whom allocated & why**	**How allocated/mitigated**
Governmental	Acts Shared—not foreseeable or controllable	Include a suspension of work clause
Adverse Weather	Shared—not foreseeable or controllable	Include a time extension clause
Acts of God	Shared—not foreseeable or controllable	Include a time extension clause
Cost Escalation	Shared—not foreseeable or controllable	Provide a contractual formula to pay escalation on long term contracts

Table 2.16 Allocating Resource and Project Pre-requisite Risks.

Allocating Resource and Project Pre-requisite Risks		
Risk	**To whom allocated & why**	**How allocated/mitigated**
Adequacy of Project Funding	Owner—it's the owner's project	Include contract language giving the contractor the right to confirm availability of funds
Adequacy of Labor Force	Contractor—can best assess at time of bidding	Owner should consider known labor shortage in a particular trade (e.g., ironworkers) in making decisions on alternate materials; owner should consider projected surplus/ shortage in determining project performance time
Permits and Licenses	Shared—both parties have some ability to control	Owner should identify all requirements to extent possible; contractor has some lead role in compliance
Site Access	Owner—it's the owner's site	Owner should identify requirements early and then delineate site availability/ constraints in bidding documents

Table 2.17 Allocating Performance Related Risks.

Allocating Performance Related Risks		
Risk	**To whom allocated & why**	**How allocated/mitigated**
Inadequate Plans	Owner-funds design	Retain a qualified design professional; fund adequate design
Underestimation of Costs	Contractor - controllable	Use a competent estimating staff
Owner-furnished Material and Equipment	Owner-elects to use this method	Preplan for purchases, expediting; include contractual remedies for quality or delay problems
Contractor-furnished Material and Equipment	Contractor-typical scenario	Preplan for purchases, expediting; use remedies from vendors
Means and Methods of Construction	Contractor-area of expertise	Use/follow “standard” language
Delay in Presenting Problems	Claiming party-controls ability to give notice	Use/follow/enforce notice provisions
Delay in Addressing and Solving Problems	Party receiving claim -has obligation to respond	Delegate decision-making authority; Empowerment
Subsurface Conditions	Owner-owns	site Use a differing site conditions clause; eliminate disclaimers on geotechnical data
Worker and Site Safety	Contractor-controls means/methods	Use clear contract language assigning responsibility

3. RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter addresses the research design and methodology adapted for capturing the data needed to achieve the aim and objectives of the research, conduct the analysis and draw the conclusions and recommendations. It is organized in sections covering research design, research approach, research strategies/ design (methodology), research method choice, time horizon, sampling, design of questionnaire, reliability of questionnaire, and data collection and analysis techniques.

3.2 RESEARCH DESIGN

Research, from a broader perspective relates to set of activities undertaken with the purpose of providing solution(s) to a problem Sanda *et al.*(2016). A research design is the logic that links the data to be collected and the conclusions to be drawn to the initial questions of a study Malalgoda *et al.* (2013). Further to this, a research design focuses on the end-product and all the steps in the process to achieve that outcome. In this sense, a research design is viewed as the functional plan in which certain research methods and procedures are linked together to acquire a reliable and valid body of data for empirically grounded analyses, conclusions and theory formulation Vosloo (2014). The research design thus provides the researcher with a clear research framework; it guides the methods, decisions and sets the basis for interpretation.

For the purposes of this study, as this research focuses on the building contractors risk source associated with the contracts. Initially it consists of literature survey which was carried out to provide the back ground information of risk in construction contract. After that the questionnaire was designed and developed based on the objectives of the study determined during the early stage of the research and the information found in the literature reviewed. Then distributed and collected for analysis from the randomly selected respondents comprise of contractors of Class one to three. Finally, conclusion and recommendation is made from the results of the analysis.

3.3 RESEARCH APPROACH

According to Hakansson (2013) research approaches are used for drawing conclusions and establishing what is true or false. The most common approaches are deductive and inductive but there is also a mixed approach, called abductive Hakansson (2013) and Saunders *et*

al.(2015). According to Saunders *et al*.(2009) the deductive approach, in which someone develop a theory and hypothesis (or hypotheses) and design a research strategy to test the hypothesis. This author more described that deduction owes much to what we would think of as scientific research. It involves the development of a theory that is subjected to a rigorous test. In addition this approach derives conclusions from known premises (ground) Hakansson (2013). Similarly Saunders *et al*.(2009) stated that in the inductive approach, in which someone would collect data and develop theory as a result of his/her data analysis. The purpose of this approach is to get a feel of what was going on, so as to understand better the nature of the problem. In addition, this approach establishes a general proposition from particular facts Hakansson (2013). The abductive approach uses both deductive and inductive approaches to establish conclusions Hakansson (2013) and Saunders *et al*.(2015). In this method, the hypothesis, that best explain the relevant evidence, is chosen. The approach starts with an incomplete set of data or observations and uses preconditions to infer or explain conclusions Hakansson (2013). According to Saunders *et al*. (2015) data are used to explore a phenomenon, identify themes and explain patterns, to generate a new or modify an existing theory which is subsequently tested, often through additional data collection.

In the case of this research, abductive approach is better. Hence, the research carried out is cross sectional method, quantitative data is collected, and the data analysis is done based on data collection through survey method using questionnaire.

3.4 RESEARCH STRATEGIES / DESIGNS (METHODOLOGIES)

The research strategies and designs are the guidelines, or the methodologies, for carrying out the research. The guidelines (methodologies) for the research, which includes organizing, planning, designing and conducting research Hakansson (2013).

Saunders *et al*.(2009) describes research strategy as a strategy which will allow you to answer your particular research question(s) and meet your objectives. In addition to this the authors emphasize that your choice of research strategy will be guided by your research question(s) and objectives, the extent of existing knowledge, the amount of time and other resources you have available, as well as your own philosophical underpinnings. In line with this authors grouped the research strategy in to:

- survey;
- case study;
- experiment;

- action research;
- grounded theory;
- ethnography;
- archival research.

According to Creswell (2009) cited Babbie (1990) survey provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population. In addition, the survey strategy allows someone to collect quantitative data which he/she can analyze quantitatively using descriptive and inferential (deductive) statistics Saunders *et al*.(2009). Furthermore, it includes cross sectional and longitudinal studies using questionnaires or structured interviews for data collection, with the intent of generalizing from a sample to a population Creswell (2009) cited Babbie (1990). As state by Hakansson (2013) it is a descriptive research method, which examines the frequency and relationships between variables and describes phenomenon that are not directly observed.

In this regard, this research apply survey from above mentioned strategies. Since, this strategy enables the researcher to organize the questions and receive replies without actually having to talk to every respondent. As a method of data collection, it is a very flexible tool, that has the advantages of having a structured format, is easy and convenient for respondents, and is cheap and quick to administer to a large number of cases covering large geographical areas. In addition this strategy is usually associated with deductive approach. It is a popular and common strategy in business and management research and is most frequently used to answer who, what, where, how much and how many questions Saunders *et al*. (2009).

3.5 RESEARCH METHODS CHOICE

According to Hakansson (2013) the basic categories of research methods are, commonly, quantitative research method and qualitative research method. These two methods apply on projects that are either numerical or non-numerical. One of the research methods must be selected, which decides whether the project is of quantitative character or qualitative character. This is the first choice of scientific standpoint and will affect the choice of research methods, strategies, data collection and analysis. As stated by Saunders *et al*.(2009) quantitative is predominantly used as a synonym for any data collection technique (such as a questionnaire) or data analysis procedure (such as graphs or statistics) that generates or uses numerical data. In contrast, qualitative is used predominantly as a synonym for any data collection technique (such as an interview) or data analysis procedure (such as categorizing

data) that generates or use non-numerical data. Qualitative therefore can refer to data other than words, such as pictures and video clips. Table below provides difference between the two methods.

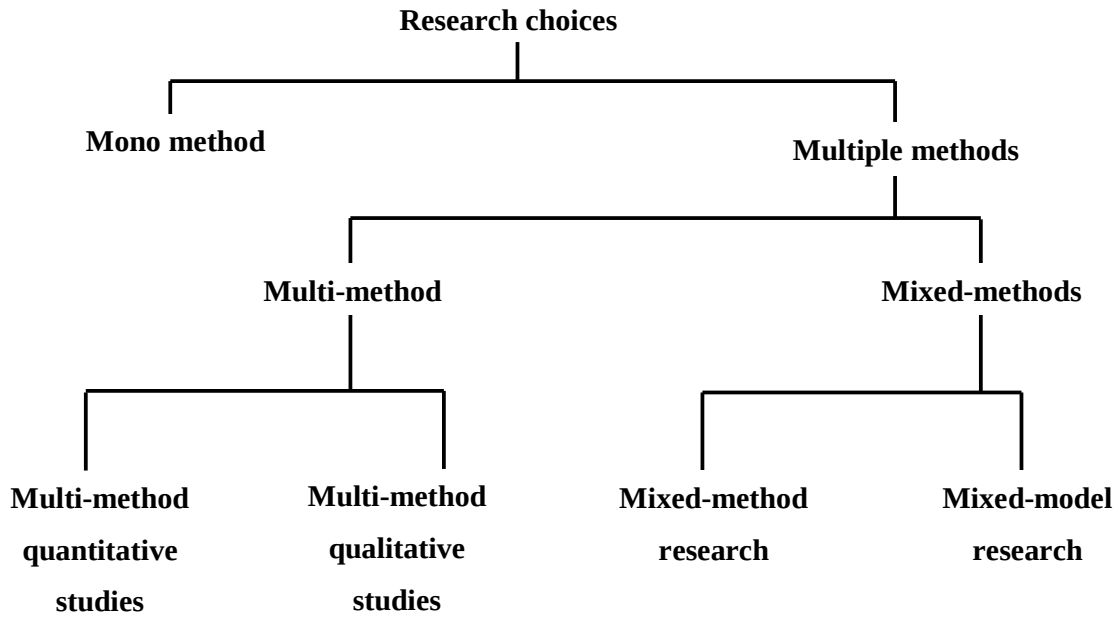
Table 3.1 Distinctions between quantitative and qualitative data

Quantitative data	Qualitative data
Based on meanings derived from numbers	Based on meanings expressed through words
Collection results in numerical and standardized data	Collection results in non-standardized data requiring classification into categories
Analysis conducted through the use of diagrams and statistics	Analysis conducted through the use of Conceptualization

Saunders *et al*.(2009), p.482.

According to Hakansson (2013) quantitative research method supports experiments and testing by measuring variables to verify or falsify theories and hypothesis. The formation of the hypothesis is that it has to be measureable with quantifications. On the other hand the qualitative research method concerns understanding meanings, opinions and behaviors to reach tentative hypotheses and theories. The method commonly uses smaller data sets that are sufficient enough to reach reliable results, where the data collection continues until saturation is reached. According to Saunders *et al*.(2009) individual quantitative and qualitative techniques and procedures do not exist in isolation. In choosing the research methods it will therefore either use a single data collection technique and corresponding analysis procedures (mono method) or use more than one data collection technique and analysis procedures to answer the research question (multiple methods). This author, further stated that: in the research if someone choose to use a mono method he/she will combine either a single quantitative data collection technique, such as questionnaires, with quantitative data analysis procedures; or a single qualitative data collection technique, such as in depth interviews, with qualitative data analysis procedures. In contrast, if he/she choose to combine data collection techniques and procedures using some form of multiple methods design, there are four different possibilities that are available as indicated in the Figure 3.1 below. Accordingly, this

research adopt a mono method research choices. In this regard, a questionnaire (quantitative method) will be in use as a research instrument. In addition random stratified sampling technique with paper based survey, and statistical analysis are used as a sampling technique, data collection, and data analysis to answer the research question.



Adapted from Saunders *et al*.(2009) , page 152.

Figure 3.1 Research choice

3.6 TIME HORIZON

According to Saunders *et al*. (2009) there are two methods to lead a study concerning time horizons; cross sectional study and longitudinal study. The author further distinguished them by speaking of "snapshot" for cross- sectional study and "diary" for longitudinal study. According to Hakansson (2013) cross-sectional surveys collect information on a population, at a single point of time on contrary longitudinal surveys collect data over a period of time.

Consequently, the study strategy adopted here will be a cross sectional method. As stated by Saunders *et al*.(2009) a cross sectional research is a study of particular phenomenon at a particular time. Most research projects are undertaken for academic courses which are time constrained and the researchers follow the cross sectional study method. This research is done for academic purpose and the research carried out is cross sectional approach. The questionnaires were directed to engineers, contractors and project managers who have different years of experience in the building construction and participated at least on one

PPPAA(2011) based construction project . In addition they are having different views and beliefs from different construction firms on the building contractor's risk sources associated with the contract's delivered through the PPPAA's standard bidding document.

3.7 SAMPLING

There are three main justifications for using sampling: Sampling can provide reliable information at far less cost than a census (survey). Data can be collected more quickly, and estimates can be published in a timely fashion. Finally, and less well known, estimates based on sample surveys are often more accurate than those based on a census because investigators can be more careful when collecting data Sharon (2010).

According to Saunders *et al*.(2009) and Walliman (2011) there are two types of sampling methods: probability sampling and non probability sampling. Saunders *et al*.(2009) probability sampling or representative sampling is most commonly associated with survey based research strategies where someone need to make inferences from his/her sample about a population to answer his/her research question(s) or to meet his/her objectives. Saunders *et al*.(2009) and Lohr (2010) further divides probability sampling method in to four parts. These are simple random, stratified, cluster, and systematic sampling method and Saunders *et al*.(2009) included the fifth one multistage sampling. Since, the population from which a sample is to be drawn does not constitute a homogeneous group; this study used stratified sampling techniques to obtain a representative sample. Under this method the population is divided in to several sub populations that are individually more homogeneous than the total population. The sub population are called strata. The following procedure is observed for stratification.

The writer has obtained the list of contractors from ministry of urban development and housing (MUDHo) website those registered on the budget year 2009 E.C. (from July 1-2008 E.C to May 10-2009 E.C.). Accordingly the samples were selected from the stratum target population of grade first to three contracting companies. A total population of 438 with each licensing grade having a population of 164,75 and 199 respectively.

Then representative random sample was taken, based on J. Carvalho (1984) sample size determination Table 3.2 shown below.

Table 3.2 Sample size determination table

No	Population size	Small	Medium	Large
1	**51-90**	5	**13**	20
2	91-150	8	20	32
3	**151-280**	13	**32**	50
4	281-500	20	50	80
5	501-1,200	32	80	125
6	1,201-3,200	50	125	200
7	3,201-10,000	80	200	315
8	10,001-35,000	125	315	500
9	35,001-150,000	200	500	800

J. Carvalho (1984), page 61.

Accordingly, the required sample size for this research is 77. This assumes that 50 percent return rate of the questionnaire results in a minimum returned sample size or data to be analyzed. Therefore, the total questionnaire distributed to grade one - three contracting companies were 154.

3.8 DESIGN OF THE QUESTIONNAIRE

According to Saunders *et al.*(2009) cites Bourque and Clark (1994) when designing individual questions researchers do one of three things: adopt questions; or adapt questions used in other questionnaires; or develop their own questions. Accordingly, in order to answer the question raised based on the aim and objective of this research the researcher identified different risk factors from reviewed literature. Then the questionnaire was developed following the comment given by the advisor. Thus, it gather information from professionals working in the construction industry in Ethiopia and those participated at least on one PPPAA (2011) based construction project (this is done by including a note for the respondents that states to consider only those projects delivered using the PPPAA's SBD). Also to get potential answers from respondents in relation to the aim of the study. Respondents record their own responses in the spaces provided on the questionnaire, according to set instructions. Closed-ended questions were used and the respondents marked the category that best described their opinion regarding the question on the building contractors risk sources

associated with the standard bidding document for the procurement of works in Ethiopia. The questionnaires were divided into two parts, as presented in **Appendix I** , to gather the following information:

- Part I: Personal data about the respondents and the company's profile.
- Part II: To explore common contract provisions that form as risks to contractor and to explore risks that building contractors are exposed to the SBD for the procurement of works, issued by PPPAA NCB(2011). And raises a question those mentioned on **section 1.7** based on the listed objectives on **section 1.6**.

Drawn from the literature, **Appendix I** also provides the justifications for each questions raised as well as the selection of potential ranges.

3.9 RELIABILITY OF THE QUESTIONNAIRE

The researcher made the following assumptions when designing the questionnaire:

- That the respondents would provide honest answers to the questions;
- That the respondents are aware of the building contractors risk sources associated with the standard bidding document for the procurement of works in Ethiopia;
- That the questions are straightforward, simple and unambiguous and of relevance to the respondents, thus facilitating the respondents understanding of the questions; and
- That the relevant information required by the researcher would be provided by the respondents.

3.10 DATA COLLECTION AND ANALYSIS TECHNIQUE

The method for collecting research data is often determined by the research strategy. This research adopt the survey strategy in line with the research question. Techniques for collecting data in this strategies includes questionnaire, structured observation and structured interviews Saunders *et al*.(2009). In line with the research questions and purpose of the study, this research adopt questionnaires as techniques for data collection for the research. Questionnaire were provided for primary data collection, while journals, books, published and unpublished research papers were provided as secondary data for this research.

The data collected from the research were subjected to quantitative analysis. This analysis is based on describing and interpreting objects statistically and with numbers. It aims to interpret the data collected for the phenomenon through numeric variables and statistics. It also includes computational and statistical methods of analysis. Accordingly, in this research

the first section (general information) as part of the data is presented using tables, percentage proportion method. The second section (section B) part of the data in question one probability of occurrence and impact part, since the qualitative risk analysis is used in this research to describe and understand each risk factor, so as to know the more significant risks. Quantitative analysis is further employed to compute the weighted average score (WAS) of ranking of each risk factor. A two dimensional scale is employed as shown in Tables below (Table 3.3 and Table 3.4); respondents were requested to score or rate on a likert type scale of 1-5, the likelihood of occurrence and Impact of the risk factors on contractors.

Using the responses obtained from the questionnaires, weighted average score (WAS) for each risk factor was calculated for the likelihood of occurrence and the consequence and ranked. The formula of the weighted average score (WAS) adopted from El-Sayegh (2014) is presented in Equation 1.

Weighted average score, WAS $= \frac{\sum_{i=1}^{5} Wi\ Xi}{\sum_{i=1}^{5} Xi}$……. Equation (1)

Where:

wi= weight assigned to i^{th} response

xi= frequency of the response

i= response category index = 1, 2, 3, 4 and 5 for Rare /very low, Unlikely / low, Possible / Moderate, Likely / high and Most likely / very high respectively.

The result of WAS ranges between 1-5 and these results were then used to assign the level of risk on the likelihood of occurrence and impact into risk matrix analysis. The results assigned in the matrix analysis is shown in Table below (Table 3.5).

Risk Analysis Matrix is one of tools and techniques of qualitative risk analysis method using a subjective assessment table of very low, low, moderate, high and very high indicators to show the level of each type of risk factor discussed. Risk analysis matrix was used to provide an indicative level of risks to reflect the degree of risks in each category.

Table 3.3 Likelihood of risk events

Score	Description	Explanation
1	Very low	Not expected to happen
2	Low	Small likelihood but could will happen
3	Moderate	50-50 chance
4	High	More than 50-50 chance
5	Very high	Almost certain that it will happen

Source PMBOK (2013).

Table 3.4 Impact of risk

Project objectives score	**Very low**	**Low**	**Moderate**	**High**	**Very high**
	1	**2**	**3**	**4**	**5**
Cost	Insignificant cost increase	< 10% cost increase	10 – 15% cost increase	15 – 30% cost increase	>30% cost increase
Time/ Schedule	Insignificant Time/Schedule increase	< 5% Time/Schedule increase	5-10% Time/Schedule increase	10-20% Time/Schedule increase	Time/schedule Increase >20%
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction Requires client Approval	Quality reduction unacceptable to the client	Project end item effectively unusable

adapted PMBOK (2013).

Table 3.5 Grading for the risk analysis table

Grading	Likelihood of Occurrence	Impact
1.0 =< 1.5	Rare	Very low
1.5 =< 2.5	Unlikely	Low
2.5 =< 3.5	Possible	Moderate
3.5 =< 4.5	Likely	High
4.5 =<5.0	Most likely	Very high

Nathaniel (2012) cites Alkali (2010).

Then a statistical test, Spearman's rank correlation coefficient **(rho)** (ρ) method is used to know grade one to three contractors understanding on building construction contract risks based on their probability of occurrence and impacts on a project delivered by the PPPAA's 2011 SBD. Where, the Spearman's rank correlation coefficient is a nonparametric measure of rank correlation (statistical dependence between the rankings of two variables). It is a technique used to assess how well the relationship between two variables. For this research between class 1 and class 2, class 1 and class 3, and class 2 and class3 contractors correlations are tested a correlation coefficient of +1 means perfect positive correlation (agreement), a correlation coefficient near to zero means no correlation, and a correlation coefficient of -1 means perfect negative correlation (disagreement). In addition to these C. Undan (2005) states correlation coefficients between -.20 and +.20 indicate a weak relation between two variables, those between .20 and .50 (either positive or negative) represent a moderate relationship, and those larger than .50 (either positive or negative) represent a strong relationship.

This correlation coefficient (rho) (ρ) is calculated using the following formula as mentioned by different researchers such as Zinabu Tebeje and Getachew Teka (2015), Desai Megha and Bhatt Rajiv (2013).

rho(ρ)= 1−[(6 Σ d^2) / (n^3− n)]……. Equation (2).

Where:

rho(ρ)is the Spearman rank correlation coefficient between two parties.

d is the difference between ranks assigned to variables for each factor.

and n is the number of subjects or data pairs of rank.

However, for the case of this research since the analysis of the data from the questionnaire is done using excel the syntax for Spearman's rank correlation coefficient is :CORREL(array1,array2), Where: Array1 is a cell range of values, and Array2 is a second cell range of values.

Finally, question number two risk management approach section and question number three how risk management practice can be promoted in Ethiopian's building construction, the output of the analyzed data is presented using tables, graphs and simple percentage for further interpretation and discussion.

4. ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

The analysis and discussion below is devised in three parts in line with the objectives of this research and also the sections of the questionnaire. As stated in the previous chapter a total of 154 questionnaire were distributed to the randomly selected class one to three general and building contractors of Ethiopia. Of these 154 questionnaire 77 questionnaires were returned at the proper time completed. Accordingly used as the bases of the analysis of the research. The analysis and discussion are divided under several headings based on the objectives of the study.

4.2 QUESTIONNAIRES RESPONSE RATE

The study has focused on the grade one to three contractors in Ethiopia. As mentioned on previous chapter from 154 questionnaires distributed, a minimum returned sample size or data to be analyzed is 77. As provided in, Table 3.2 in section 3.7 sample size determination table, the medium sample size required were 32,13, and 32 for each category of contractors of class one and three. In this regard, the result found from the respondent shows that both over all response and individual response is statistically enough. In order to stick with good statistical validity, the study made use of representative sample as discussed above. And the validity of each response is checked by explaining each question to the respondent to avoid bias they face. Following the questionnaire is delivered to the required (experienced) respondent and checking the completeness of the response after the response was given by the respondent. Thus, out of 80 returned questionnaire two response from GC/BC1 contractors and one response from GC/BC2 contractors were discarded because of their incomplete or partial response. This responses are identified during data analysis period and their validity is checked based on the number of answers given in the questionnaire. The details of the respondent response and its rate are summarized in the Table below (Table 4.1).

Table 4.1 The respondent response and its rate

Respondents class	Questionnaire		Valid response	Valid among distributed in %
	Distributed	Returned		
GC/BC 1	64	34	32	50.00
GC/BC 2	26	14	13	50.00
GC/BC 3	64	32	32	50.00
Total	154	80	77	

4.3 GENERAL INFORMATION OF RESPONDENT

The general information part of the questionnaire contains two sections that is, the company and respondents profile. In the company profile section company work experience, licensing grade, and proportion of projects under taken are included. It is important for the researcher to get information about the company experience in the construction industry and to categorize and examine their knowledge in contract risk management practice in the building construction project. Hence, company work experience tells that the companies have been in the industry long enough to furnish/ supply reliable responses in contract risk management and the maturity of the company. In addition, company licensing grade to analyze the knowledge of contract risk management practice in each class of contractor's grade one to three as a result Table 4.2 and Table 4.3 shows the respondents company work experience in the construction industry and their licensing grade. Since, the research deals with contract risk management in the DBB contract and to identify the type of work most respondents do under this type of delivery system proportion of project undertaken is included.

Table 4. 2 Company work experience in the construction industry

No.	Work experience (years)	Number of respondents	Percentage (%)	Cumulative
1	0-5	8	10.39	10.39
2	5-10	17	22.08	32.47
3	>10	52	67.53	100

Table 4. 3 Company licensing grade

No	Contractors Grade	Number of respondent	Percentage (%)	Cumulative
1	BC-1	28	36.4	36.4
2	BC-2	11	14.3	50.6
3	BC-3	30	39.0	89.6
4	GC-1	4	5.2	94.8
5	GC-2	2	2.6	97.4
6	GC-3	2	2.6	100.0

Thus, Table 4.4 shows the type of project under taken by respondent. This result revealed that most of the respondent under take public/community building which is an advantage to the findings of this research.

Table 4. 4 Type of projects under taken by the respondents company

Type of projects under taken	Percentages of projects under taken					Total percentage (%)
	0-10%	10-30%	30-50%	50-70%	70-100%	
Commercial / industry buildings	5	15	8	4	3	31.5
Public/ community buildings	0	0	6	17	53	68.5

Similarly, as mentioned earlier it is important for the researcher to get information about the respondent profile in the construction industry so as to categorize and examine their knowledge in contract risk management practice in the building construction project those administered under PPPAA's contract. As a result, the respondents profile section, position or responsibility and total work experience are included in the questionnaire and Table 4.5 and 4.6 presents the respondents response respectively. Thus, the result obtained from the survey shows that, most of the respondents are at the top management level and have quite a reasonable working experience in the construction industry.

Table 4. 5 Respondents position or responsibility

No.	Position/Responsibility	Number of respondent	Percentage (%)	Cumulative
1	General manager	4	0.05	0.05
2	Deputy manager	5	0.06	0.12
3	Project manager	34	0.44	0.56
4	Operation manager	5	0.06	0.62
5	Office engineer	29	0.38	1.00

Table 4. 6 Respondents work experience

No.	Respondents work experience	Total work experience (years)	No of respondents	Percentage (%)
1	In the construction industry	0-5	16	0.21
		5-10	20	0.26
		>10	41	0.53
2	Within the company	0-5	48	0.62
		5-10	23	0.30
		>10	6	0.08

4.4 POTENTIAL RISK FACTORS

The first objective of this research is to identify and evaluate potential risk factors contractors are exposed while executing a contract. In assessing risks contractors are exposed to within the PPPAA's forms of contract, 59 potential risk factors were identified and grouped in to seven main group from the literature reviewed as stated in chapter two Table 2.4. These groups were: Physical works, delay and disputes, direction and supervision, damage and injury to person and property, external factors, payment, and law and arbitration.

In addition, as the second objective of this research is to determine the likelihood of occurrence and impact of the identified risk factors the next section presents this according to the response given by the respondents.

4.5 THE PROBABILITY OF OCCURRENCE OF THE RISK FACTORS

As stated by Jackson (2004) a risk is characterized by its probability of occurrence and its uncertain impact on project objectives. It has two elements: the likelihood or probability of something happening, and the consequences or impacts if it does Cooper *et al.*(2005). This study sought to know the probability of occurrence of the identified risk factors contractors are exposed while executing a contract in Ethiopian building construction project under PPPAA's standard bidding document. Based on the respondent's response class one to three GC and BC contractors the combined weighted average score (WAS) and rank as indicated in the **Appendix II** is calculated for each risk factor based on the likelihood of occurrence. Then the important and top four ranked risk factor are selected as indicated in Table 4.7. According to the ranking from the WAS, respondents identified inadequacy of time or finance, late supply of information/ design data/ drawing, defective design, financial constraint, delay in payment, and inflation as the highly occurring risk factor based on the level of occurrence. According to similar study conducted by Nathaniel (2012) out of this identified risk factors late supply of information/ design data/ drawing, defective design, and delay in payment were ranked top on their probability of occurrence. Delay in payment, inadequacy of finance, inflation, and exchange rate have been identified as highly occurring risk factors on project in terms of time, cost and quality C. S. Goh and H. Abdul-Rahman (2013). In line with this the agreement between the respondent in ranking the problem have been calculated through spears man correlation coefficient. The spears man correlation in the **appendix V** shows strong positive agreement between the contractors. These strong correlation shows that most of the respondents have the same opinion about the probability of occurrence of contract risk factors contractors exposed while executing a contract in Ethiopian building construction project under PPPAA's standard bidding document. Thus, great effort is required by the contractors to reduce these high occurring risks in to moderate or low.

Table 4. 7 The likely occurrence of top risk factors from each group identified by the respondent

		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of occurrence**
A) Physical works													
11	Inadequacy of time or finance	3.50	1	Possible	3.77	2	Likely	3.75	1	Likely	3.67	1	likely
1	Change in ground condition	2.91	5	Possible	3.92	1	Likely	3.44	2	possible	3.42	2	possible
10	Inadequacy of material	3.28	2	Possible	3.15	4	possible	3.31	6	possible	3.25	3	possible
4	Tests and samples approval (materials provided by contractor)	2.91	5	Possible	3.08	6	possible	3.38	4	possible	3.12	4	possible
B) Delay and disputes													
2	Late supply of information/ design data/drawing	3.41	1	Possible	3.69	1	Likely	3.69	1	likely	3.60	1	likely
1	Possession of site	2.91	2	Possible	3.38	2	possible	3.16	2	possible	3.15	2	possible
3	Inefficient execution of work	2.56	4	Possible	3.00	3	possible	2.94	4	possible	2.83	3	possible
5	Layout (design) dispute	2.63	3	Possible	2.62	5	possible	3.09	3	possible	2.78	4	possible
C) Direction and supervision													
8	Defective designs	3.34	1	Possible	3.77	1	Likely	3.97	1	likely	3.69	1	likely
7	Mistakes in documents	3.09	2	Possible	3.62	2	Likely	3.75	2	likely	3.49	2	possible
1	Greed (insatiability) of supervisor	2.97	3	Possible	2.92	5	possible	3.47	3	possible	3.12	3	possible
2	Incompetence (luck of skill)	2.97	3	Possible	3.08	3	possible	3.16	4	possible	3.07	4	possible
D) Damage and injury to persons and property													
3	Accidents within the construction site	3.03	1	Possible	2.92	1	possible	2.84	1	possible	2.93	1	possible

1	Negligence or breach of warranty	2.75	2	Possible	2.85	2	possible	2.47	2	unlikely	2.69	2	possible
7	Gaps and time limits in insurance cover	2.72	3	Possible	2.62	3	possible	2.22	3	unlikely	2.52	3	possible
2	Uninsurable matters	2.38	4	Unlikely	2.38	4	unlikely	2.22	3	unlikely	2.33	4	unlikely
E) External factors													
5	Financial constraints	3.59	1	Likely	3.62	1	Likely	3.81	1	likely	3.67	1	likely
4	Planning approvals	2.97	3	Possible	3.08	2	possible	3.13	2	possible	3.06	2	possible
6	Energy or pay restraints	3.03	2	Possible	2.62	3	possible	2.63	3	possible	2.76	3	possible
1	Government policy on taxes	2.22	4	Unlikely	2.54	4	possible	2.22	4	unlikely	2.33	4	unlikely
F) Payment													
2	Delay in payment	4.31	1	Likely	4.15	1	Likely	4.28	1	likely	4.25	1	likely
8	Inflation	3.88	2	Likely	3.92	2	Likely	3.94	2	likely	3.91	2	likely
1	Delay in settling claims and certifying	3.63	3	Likely	3.62	3	Likely	3.16	5	possible	3.47	3	possible
5	Funding constraints	3.34	4	Possible	3.31	4	possible	3.53	3	likely	3.39	4	possible
G) Law and arbitration													
3	Uncertainty due to lack of records or ambiguity of contract	2.88	1	Possible	3.31	1	possible	3.38	1	possible	3.19	1	possible
4	Cost of obtaining decision	2.38	2	Unlikely	2.77	2	possible	3.16	2	possible	2.77	2	possible
1	Delay in resolving disputes	2.38	2	Unlikely	2.77	2	possible	3.09	3	possible	2.75	3	possible
2	Injustice (unfairness)	2.28	4	Unlikely	2.77	2	possible	2.84	5	possible	2.63	4	possible

4.6 THE IMPACT OF THE RISK FACTORS

Similarly, the results of the finding based on the response on the impact (over all, time, cost, and quality) of potential risk factors from contractors perspective were presented in the **Appendix II**. In addition to these the important and top four ranked risk factor are selected from each group of risk factors based on the level of impact and are presented as indicated in the Table 4.8, 4.9, 4.10, and 4.11. Among the top four risks found in each group, respondents identified inadequacy of time or finance, exchange rate, delay in settling claim were identified as the highest risk factor based on the level of impact on overall performance, time and cost.

Defective design, financial constraints, inflation were also identified as the highest risk factor based on the level of impact on overall performance, time, cost and quality. Similarly, delay in payment and mistakes in document were identified as the highest risk factor based on the level of impact on time, cost, and quality, and impact on time and cost respectively on a project as delivered by the PPPAA's standard bidding document.

Then the agreement between the respondents (that is between grade one and two, grade one and three, and grade two and three contractors) in ranking the impact of contract risk factors of each group have been calculated through Spearman's rank correlation coefficient as indicated in Appendix V. The Spearman's rank correlation coefficient shows that, except class one and two contractors on group B risk factor, class one and three on group A, and group B risk factors with positive moderate, positive moderate and negative moderate correlation, there is a strong positive agreement between all contractors. These strong correlation shows that most of the respondents have the same opinion about the impact (over all, time, cost, and quality) of contract risk factors contractors exposed while executing a contract in Ethiopian building construction project under PPPAA's standard bidding document.

As stated on literature reviewed, the concept of risk in a project context is a chance of something that will have an impact upon objectives. It includes the possibility of loss or gain, or variation from a desired planned outcome, as a consequence of the uncertainty associated with following a particular course of action. Also, concerning about potential impacts on project objectives; project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost,

and quality. In addition risk by nature has strong influence on the contractors depending on the level of impact. According to similar study conducted by Nathaniel (2012) among these identified risk factors delay in payment and defective design was the top risk factor based on their level of impact on projects. Also Wiguna and Scott (2005) identified inflation, defective design, and delay in payment top risk factors having an impact on project time and cost. Delay in payment, inadequacy of finance, inflation, and exchange rate have been identified as high negative impact on project performance in terms of time, cost and quality Goh and Abdul-Rahman (2013).Therefore it is necessary for contractors to concentrate his efforts on reducing these high degree risks to moderate risks that have negligible impact, moderate risks to low level risk and also monitor low risks to ensure they do not increase in level.

Table 4.8 The top risk factors identified having an impact on overall performance

		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**
A) Physical works													
11	Inadequacy of time or finance	3.81	1	Likely	3.85	1	Likely	3.97	1	Likely	3.88	1	likely
10	Inadequacy of material	3.31	2	Possible	3.54	2	Likely	3.59	2	Likely	3.48	2	possible
9	Inadequacy of plant/equipment	3.31	2	Possible	3.54	2	Likely	3.25	6	possible	3.37	3	possible
8	Inadequacy labor	3.16	5	Possible	3.38	4	Possible	3.31	4	possible	3.28	4	possible
B) Delay and disputes													
2	Late supply of information/ design data/drawing	3.22	2	Possible	3.31	3	Possible	3.69	1	Likely	3.40	1	possible
3	Inefficient execution of work	3.00	3	Possible	3.46	1	Possible	3.41	3	possible	3.29	2	possible
5	Layout (design) dispute	3.31	1	Possible	3.00	5	Possible	3.44	2	possible	3.25	3	possible
1	Possession of site	3.00	3	Possible	3.38	2	Possible	3.19	4	possible	3.19	4	possible
C) Direction and supervision													
8	Defective designs	3.88	1	Likely	4.08	1	Likely	3.59	1	Likely	3.85	1	likely
7	Mistakes in documents	3.25	3	Possible	3.69	2	Likely	3.41	3	possible	3.45	2	possible
2	Incompetence (luck of skill)	3.50	2	Possible	3.31	4	Possible	3.38	4	possible	3.39	3	possible
1	Greed (insatiability) of supervisor	3.19	5	Possible	3.38	3	Possible	3.38	4	possible	3.32	4	possible
D) Damage and injury to persons and property													
3	Accidents within the construction site	3.19	2	Possible	2.77	1	Possible	2.97	1	possible	2.98	1	possible
1	Negligence or breach of warranty	3.25	1	Possible	2.77	1	Possible	2.59	2	possible	2.87	2	possible

7	Gaps and time limits in insurance cover	2.81	3	Possible	2.69	3	Possible	2.59	2	possible	2.70	3	possible
2	Uninsurable matters	2.66	4	Possible	2.54	5	Possible	2.41	5	unlikely	2.53	4	possible
E) External factors													
5	Financial constraints	3.81	1	Likely	4.00	1	Likely	4.03	1	Likely	3.95	1	likely
4	Planning approvals	3.19	2	Possible	3.23	2	Possible	3.22	2	possible	3.21	2	possible
1	Government policy on taxes	3.03	3	Possible	3.08	3	Possible	2.69	4	possible	2.93	3	possible
6	Energy or pay restraints	3.00	4	Possible	2.85	4	Possible	2.91	3	possible	2.92	4	possible
F) Payment													
8	Inflation	4.31	1	Likely	4.15	1	Likely	4.16	1	Likely	4.21	1	likely
2	Delay in payment	4.03	3	Likely	4.08	2	Likely	4.09	2	Likely	4.07	2	likely
7	Exchange rates	4.25	2	Likely	4.08	2	Likely	3.84	3	Likely	4.06	3	likely
1	Delay in settling claims and certifying	4.03	3	Likely	3.92	4	Likely	3.53	4	Likely	3.83	4	likely
G) Law and arbitration													
3	Uncertainty due to lack of records or ambiguity of contract	3.03	1	Possible	3.54	1	Likely	3.28	3	possible	3.28	1	possible
1	Delay in resolving disputes	3.03	1	Possible	3.38	2	Possible	3.34	2	possible	3.25	2	possible
4	Cost of obtaining decision	2.91	3	Possible	3.23	3	Possible	3.47	1	possible	3.20	3	possible
2	Injustice (unfairness)	2.75	4	Possible	3.23	3	Possible	3.03	4	possible	3.00	4	possible

Table 4.9 Top risk factors identified by the respondent having an impact on time

		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**
A) Physical works													
11	Inadequacy of time or finance	4.06	1	Likely	4.31	1	Likely	4.19	1	Likely	4.19	1	likely
1	Change in ground condition	3.59	2	Likely	3.69	3	Likely	3.81	2	Likely	3.70	2	likely
10	Inadequacy of material	3.47	3	possible	3.85	2	Likely	3.56	4	Likely	3.63	3	likely
8	Inadequacy labor	3.31	4	possible	3.54	4	Likely	3.72	3	Likely	3.52	4	likely
B) Delay and disputes													
2	Late supply of information/ design data/drawing	3.50	1	possible	3.62	1	Likely	3.84	1	Likely	3.65	1	likely
1	Possession of site	3.31	2	possible	3.62	1	Likely	3.44	3	possible	3.46	2	possible
5	Layout (design) dispute	3.31	2	possible	3.31	4	Possible	3.66	2	Likely	3.43	3	possible
3	Inefficient execution of work	3.09	4	possible	3.54	3	Likely	3.41	4	possible	3.35	4	possible
C) Direction and supervision													
8	Defective designs	3.63	1	Likely	4.00	1	Likely	3.69	1	Likely	3.77	1	likely
7	Mistakes in documents	3.56	2	Likely	3.69	2	Likely	3.59	2	Likely	3.62	2	likely
2	Incompetence (luck of skill)	3.44	4	possible	3.31	3	Possible	3.44	3	possible	3.39	3	possible
11	Inappropriate consultants or contractors	3.50	3	possible	3.08	4	Possible	3.44	3	possible	3.34	4	possible
D) Damage and injury to persons and property													
3	Accidents within the construction site	3.06	1	possible	2.92	1	Possible	2.81	2	possible	2.93	1	possible
1	Negligence or breach of warranty	3.06	1	possible	2.69	2	Possible	2.84	1	possible	2.87	2	possible
7	Gaps and time limits in insurance cover	2.75	3	possible	2.62	3	Possible	2.75	3	possible	2.71	3	possible

5	Consequential losses	2.66	4	possible	2.54	4	Possible	2.56	4	possible	2.59	4	possible
E) External factors													
5	Financial constraints	3.91	1	Likely	4.15	1	Likely	4.06	1	Likely	4.04	1	likely
4	Planning approvals	3.09	2	possible	3.31	2	Possible	3.19	2	possible	3.20	2	possible
2	Labor strike	3.00	3	possible	2.69	3	Possible	2.91	3	possible	2.87	3	possible
6	Energy or pay restraints	3.00	3	possible	2.69	3	Possible	2.78	4	possible	2.82	4	possible
F) Payment													
8	Inflation	4.56	1	most likely	4.38	1	Likely	4.28	1	Likely	4.41	1	likely
2	Delay in payment	4.06	3	Likely	4.15	2	Likely	4.13	2	Likely	4.11	2	likely
7	Exchange rates	4.06	3	Likely	3.92	3	Likely	3.88	3	Likely	3.95	3	likely
1	Delay in settling claims and certifying	4.28	2	Likely	3.92	3	Likely	3.47	4	possible	3.89	4	likely
G) Law and arbitration													
1	Delay in resolving disputes	3.34	1	possible	3.46	1	Possible	3.66	1	Likely	3.49	1	possible
4	Cost of obtaining decision	3.31	2	possible	3.31	2	Possible	3.41	2	possible	3.34	2	possible
3	Uncertainty due to lack of records or ambiguity of contract	3.06	3	possible	3.31	2	Possible	3.34	3	possible	3.24	3	possible
2	Injustice (unfairness)	3.00	4	possible	3.15	4	Possible	3.03	4	possible	3.06	4	possible

Table 4.10 Top risk factor identified by the respondent having an impact on project cost

		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**
A) Physical works													
11	Inadequacy of time or finance	3.88	1	Likely	3.69	1	Likely	4.09	1	Likely	3.89	1	likely
1	Change in ground condition	3.53	2	Likely	3.31	3	Possible	3.50	3	possible	3.45	2	possible
10	Inadequacy of material	3.41	4	possible	3.38	2	Possible	3.41	5	possible	3.40	3	possible
9	Inadequacy of plant/equipment	3.44	3	possible	2.92	5	Possible	3.41	5	possible	3.26	4	possible
B) Delay and disputes													
2	Late supply of information/ design data/drawing	3.31	1	possible	3.23	3	Possible	3.53	1	likely	3.36	1	possible
3	Inefficient execution of work	3.00	3	possible	3.38	2	Possible	3.44	2	possible	3.27	2	possible
1	Possession of site	2.88	5	possible	3.46	1	Possible	3.16	4	possible	3.16	3	possible
5	Layout (design) dispute	3.06	2	possible	3.00	4	Possible	3.38	3	possible	3.15	4	possible
C) Direction and supervision													
8	Defective designs	3.88	1	Likely	4.00	1	Likely	3.66	1	likely	3.84	1	likely
7	Mistakes in documents	3.81	2	likely	3.77	2	Likely	3.56	2	likely	3.71	2	likely
2	Incompetence (luck of skill)	3.47	3	possible	3.08	4	Possible	3.44	4	possible	3.33	3	possible
11	Inappropriate consultants or contractors	3.38	4	possible	3.00	6	Possible	3.34	5	possible	3.24	4	possible
D) Damage and injury to persons and property													
3	Accidents within the construction site	3.19	1	possible	2.77	1	Possible	2.84	1	possible	2.93	1	possible
1	Negligence or breach of warranty	3.16	2	possible	2.62	3	Possible	2.81	2	possible	2.86	2	possible
7	Gaps and time limits in insurance cover	2.88	3	possible	2.69	2	Possible	2.78	3	possible	2.78	3	possible

5	Consequential losses	2.84	4	possible	2.46	4	Unlikely	2.72	4	possible	2.67	4	possible
E) External factors													
5	Financial constraints	3.88	1	likely	3.77	1	Likely	4.00	1	likely	3.88	1	likely
4	Planning approvals	2.94	3	possible	3.00	2	Possible	3.06	2	possible	3.00	2	possible
6	Energy or pay restraints	3.06	2	possible	2.85	3	Possible	2.72	5	possible	2.88	3	possible
2	Labor strike	2.94	3	possible	2.54	4	Possible	2.84	3	possible	2.77	4	possible
F) Payment													
8	Inflation	4.38	1	likely	4.08	1	Likely	4.44	1	likely	4.30	1	likely
2	Delay in payment	4.09	2	likely	3.92	2	Likely	4.06	2	likely	4.03	2	likely
7	Exchange rates	3.91	5	likely	3.77	3	Likely	3.97	3	likely	3.88	3	likely
1	Delay in settling claims and certifying	4.06	3	likely	3.77	3	Likely	3.41	5	possible	3.75	4	likely
G) Law and arbitration													
4	Cost of obtaining decision	3.34	1	possible	3.23	1	Possible	3.53	1	likely	3.37	1	possible
1	Delay in resolving disputes	2.88	3	possible	3.23	1	Possible	3.53	1	likely	3.21	2	possible
3	Uncertainty due to lack of records or ambiguity of contract	3.16	2	possible	3.15	3	Possible	3.28	3	possible	3.20	3	possible
2	Injustice (unfairness)	2.84	4	possible	3.15	3	Possible	3.00	5	possible	3.00	4	possible

Table 4.11 Top risk factor identified by the respondent having an impact on quality

		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**	**W.A.S**	**Rank**	**Level of impact**
A) Physical works													
3	Defective materials or workman ship	3.50	1	Possible	3.38	4	possible	3.47	2	Possible	3.45	1	possible
9	Inadequacy of plant/equipment	3.44	2	Possible	3.31	5	possible	3.25	5	Possible	3.33	2	possible
8	Inadequacy labor	3.03	7	Possible	3.46	1	possible	3.38	3	Possible	3.29	3	possible
11	Inadequacy of time or finance	3.06	5	Possible	3.46	1	possible	3.28	4	possible	3.27	4	possible
B) Delay and disputes													
3	Inefficient execution of work	2.88	1	Possible	3.54	1	Likely	3.22	1	possible	3.21	1	possible
5	Layout (design) dispute	2.50	3	Unlikely	2.92	2	possible	2.56	3	possible	2.66	2	possible
2	Late supply of information/ design data/drawing	2.41	4	Unlikely	2.69	3	possible	2.63	2	possible	2.57	3	possible
4	Delay outside of both parties' control	2.53	2	Possible	2.46	4	unlikely	2.19	4	unlikely	2.39	4	unlikely
C) Direction and supervision													
8	Defective designs	3.53	2	Likely	3.92	1	Likely	3.53	1	Likely	3.66	1	Likely
2	Incompetence (luck of skill)	3.59	1	Likely	3.31	3	possible	3.31	3	possible	3.40	2	Possible
11	Inappropriate consultants or contractors	3.47	3	Possible	3.00	4	possible	3.44	2	possible	3.30	3	Possible
7	Mistakes in documents	3.44	4	Possible	3.38	2	possible	3.06	5	possible	3.29	4	Possible
D) Damage and injury to persons and property													
1	Negligence or breach of warranty	2.34	2	Unlikely	2.31	1	unlikely	2.38	1	unlikely	2.34	1	Unlikely
5	Consequential losses	2.44	1	Unlikely	2.15	2	unlikely	1.97	5	unlikely	2.19	2	Unlikely
3	Accidents within the construction site	2.25	3	Unlikely	1.92	3	unlikely	2.25	2	unlikely	2.14	3	Unlikely

7	Gaps and time limits in insurance cover	2.19	4	Unlikely	1.92	3	unlikely	2.03	3	unlikely	2.05	4	Unlikely
E) External factors													
5	Financial constraints	3.44	1	Possible	3.69	1	Likely	3.44	1	possible	3.52	1	Likely
4	Planning approvals	2.38	2	Unlikely	2.46	2	unlikely	2.31	3	unlikely	2.38	2	Unlikely
2	Labor strike	2.25	6	Unlikely	2.38	3	unlikely	2.44	2	unlikely	2.36	3	Unlikely
10	Industrial disputes	2.34	3	Unlikely	2.23	4	unlikely	2.22	4	unlikely	2.26	4	Unlikely
F) Payment													
8	Inflation	4.38	1	Likely	3.46	2	possible	3.53	1	Likely	3.79	1	Likely
2	Delay in payment	4.09	2	Likely	3.54	1	Likely	3.25	2	possible	3.63	2	Likely
7	Exchange rates	3.91	5	Likely	3.31	3	possible	2.94	4	possible	3.38	3	Possible
1	Delay in settling claims and certifying	4.06	3	Likely	3.31	3	possible	2.47	6	unlikely	3.28	4	Possible
G) Law and arbitration													
1	Delay in resolving disputes	2.88	3	Possible	3.00	1	possible	2.34	4	unlikely	2.74	1	Possible
6	Changes in statutes	2.78	5	Possible	2.85	3	possible	2.50	1	unlikely	2.71	2	Possible
2	Injustice (unfairness)	2.84	4	Possible	2.92	2	possible	2.34	4	unlikely	2.70	3	Possible
4	Cost of obtaining decision	3.34	1	Possible	2.46	4	unlikely	2.19	6	unlikely	2.66	4	Possible

4.7 ALLOCATION OF IDENTIFIED RISK FACTORS FROM CONTRACTORS PERSPECTIVE

According to the third objective of the research allocation of identified risk factors from contractor perspective is presented. The Table below (Table 4.13 on page 110) shows the response of the respondent and its allocation based on FIDIC 1999 and PPPAA 2011compiled by the researcher.

As stated in section 2.5 and 2.11 since it is difficult to remove all potential risks in a construction project, it is crucial to allocate risks among parties in the project through a contract. If not, project performance in terms of cost, quality and time is often affected. Moreover, disputes and misunderstandings are often the end result between clients and contractors when the distribution of risk is not well allocated. Therefore, proper risk allocations in construction contracts can help reduce such impacts and achieve management efficiency.

When we compare the allocation presented by the respondent and the writer (me), the result shows a shortage in knowledge and lack of experience in allocating the risk to the required party. To explain this we can consider risk factors indicated in the previous discussion section 4.6 i.e. inadequacy of time or finance, mistakes in document, defective design, financial constraint, delay in settling claim, delay in payment, exchange rate and inflation those having high impact on the performance (overall, time, cost, and quality) of the project. It can be observed from Table 4.12 on page 109, for example inadequacy of finance is allocated by the writer from PPPAA's to contractor while the respondents allocated this risk factor to client, contractor, and to small percent to force measure.

Similarly, from Table 4.13 on page 110, physical works risk factor group the first two risk factors, change in ground condition and artificial obstacles. It can be observed that 64 and 57, 35 and 47, and 14 and 12 respondent allocated these risks to client, contractor and to force measure respectively. However, PPPAA 2011 allocated these risks to the client and contractor by stating that the engineer to take in to account any delay suffered by a contractor as a result of artificial obstacle or physical condition (change in ground condition) that could not reasonably have been for seen by an experienced contractor. The contractor to claim for additional payment and extension of extended completion date when these risks encountered (**Appendix D**).

On contrary, based on Bunny (2002) cites Grove (2000) there are four criteria for allocation of risks:

- **The fault standard:** cost and time impacts of risks caused (or not avoided) through the fault of a party should be borne by that party. In other words, he who makes damage shall bear the risk;
- **The foresee-ability standard:** He who is best able to foresee the risk is allocated that risk;
- **The management standard:** He who is best able to control and manage the risk is allocated that risk;
- **The incentive standard:** risks should be placed on the party most in need of incentive (presumably already with the ability) to prevent and control them. This is expected to motivate people to play their part. Compensation events or provisions of construction conditions of contract should be examined if they demonstrate this rationale (underlying principle) uniformly as contractors and employers are already motivated to avoid and mitigate risk appearance. Both parties lose when a project is impacted by cost, and time overruns regardless of risk allocation, although one may lose more than the other.

In these regard, when the writer (me) compares FIDIC (1999) and PPPAA (2011), In FIDIC forms of contract for example, where the design is performed by or on behalf of the employer, the employer is bearing the risk of its own design, and of its own acts or omissions, and the Contractor is entitled to a cost, time and profit relief in case of late drawings or instructions (Sub clause 1.8). Similarly, issues with access to the site (Sub-Clause 2.1), wrong setting out data (Sub clause 4.7) , or variations to the works (Clause 13) instructed by the engineer.

Such practice of allocation of risk also found in PPPAA. The engineer orders a delay or does not issue drawings, specifications, or instructions required for execution of the works on time (Sub clause 47.c), Failure of the public body to fulfill his obligations under the contract (73.1.e); The public body shall, in due time and in conformity with the progress of the works, place the site and access thereto…. this will be a compensation event (Sub clause 31.1), If, at any time during the execution of the works, any error appears in the position, levels, dimensions or alignment of any part of the works…… unless such error is based on incorrect data supplied by the engineer, in which case the public body shall be responsible for the cost

of rectification (Sub clause 49.2) and modifications by change orders (Clause 15). This satisfies the allocation criteria discussed above.

On the other hand for example, when we consider a risk factor such as, inflation (change in law and legislation), FIDIC, (Sub clause 13.7) allow the contract price adjustment, and PPPAA, (Sub clause 18.1) does not allow price adjustment, (Sub clause 62) adjustments of contract prices shall be allowed after twelve (12) months from the effective date of the Contract if the contract performance period is more than 18 months. This means that the criteria mentioned above about allocation of risk is not properly applied in PPPAA. As a result, it is difficult to generalize the knowledge of the respondent about risk allocation. Because PPPAA also allocate inflation risk (price adjustment) wrongly to the contractors.

Table 4.12 Risk allocation on identified high impact risk factors

		Allocation by percent from total respondent			Allocation based on (1) FIDIC 1999 and (2) PPPAA 2011		
No	**High impact risk factors identified by the respondent**	**Client**	**Contractor**	**Force measure***	**Client**	**Contractor**	**Force measure***
1	Inadequacy of time or finance	0.70	0.88	0.03		1,2	
2	Mistakes in documents	0.83	0.40	0.08	1	1,2	
3	Defective designs	0.94	0.27	0.13	1,2		
4	Financial constraints	0.84	0.83	0.09	1,2	1,2	
5	Delay in settling claims and certifying	0.83	0.48	0.14	1,2	1,2	
6	Delay in payment	0.83	0.42	0.01	1,2	1,2	
7	Exchange rates	0.38	0.35	0.65		1,2	1,2
8	Inflation	0.32	0.49	0.69		1,2	1,2

Table 4.13 Allocation of identified risk factor by respondent and researcher

Risk in a construction contract		Allocation based on the respondent			Allocation based on (1) FIDIC 1999 and (2) PPPAA 2011		
		Client	Contractor	Force measure*	Client	Contractor	Force measure*
A) Physical works							
1	Change in ground condition	64	35	14	1,2	1,2	
2	Artificial obstacles	57	47	12	1,2	1,2	
3	Defective materials or workman ship	8	63	2		1,2	
4	Tests and samples approval (materials provided by contractor)	33	56	3		1,2	
5	Exceptionally inclement weather	16	15	65			1,2
6	Site preparation	44	59	0		1,2	
7	Inadequacy (insufficient) of staff	22	72	3		1,2	
8	Inadequacy labor	3	70	5		1,2	
9	Inadequacy of plant/ equipment	5	63	5		1,2	
10	Inadequacy of material	13	71	7		1,2	
11	Inadequacy of time or finance	54	68	2	1,2	1,2	
B) Delay and disputes							
1	Possession of site	70	24	6	1,2	1,2	
2	Late supply of information/design data/drawings	71	23	3	1,2	1,2	
3	Inefficient execution of work	13	67	5		1,2	
4	Delay outside of both parties' control	19	15	62			1,2
5	Layout (design) dispute	64	36	6	1,2		
C) Direction and supervision							

1	Greed (insatiability) of supervisor	63	22	5	1,2		
2	Incompetence	63	43	5	1,2	1,2	
3	Inefficiency	56	35	4	1,2	1,2	
4	Unreasonableness	63	28	3	1,2	2	
5	Partiality	62	31	4	1,2		
6	Poor communication	66	54	3	2	1,2	
7	Mistakes in documents	64	31	6	1	1,2	
8	Defective designs	72	21	10	1,2		
9	Compliance with requirements	57	57	14	1,2	1,2	2
10	Unclear requirements	62	44	16	1,2	1,2	2
11	Inappropriate consultants or contractors	67	52	8	1,2	1,2	
12	Changes in requirements	55	38	19	1,2	1,2	2
D) Damage and injury to persons and property							
1	Negligence or breach of warranty	37	63	5	1,2	1,2	
2	Uninsurable matters	32	53	31	1	1,2	
3	Accidents within the construction site	25	69	15	1	1,2	
4	Uninsurable risks	35	45	21	1,2	1,2	
5	Consequential losses	31	58	20	1,2	1,2	
6	Exclusions (not covered by insurance)	38	47	23	1,2	1,2	
7	Gaps and time limits in insurance cover	29	50	18	1,2	1,2	
E) External factors							
1	Government policy on taxes	18	27	52		1,2	1,2
2	Labor strike	13	47	32	1,2	1,2	
3	Safety or other laws	19	48	29	1,2	1,2	

4	Planning approvals	55	32	9	1,2		
5	Financial constraints	65	64	7	1,2	1,2	
6	Energy or pay restraints	40	54	8		1,2	
7	Cost of war or civil commotion	17	25	45	1,2		
8	Malicious (hateful) damage	15	29	44	1,2		
9	Intimidation (threats)	23	28	40	1,2		
10	Industrial disputes	16	51	25		1,2	
F) Payment							
1	Delay in settling claims and certifying	64	37	11	1,2	1,2	
2	Delay in payment	64	32	1	1,2	1,2	
3	Legal limits on recovery of interest	35	26	29	1,2	2	
4	Insolvency (bankruptcy)	52	65	8	1,2	1,2	
5	Funding constraints	72	48	7	1,2	1,2	
6	Shortcomings in the measure and value process	58	54	5		1,2	
7	Exchange rates	29	27	50	1	2	1,2
8	Inflation	25	38	53	1	2	1,2
G) Law and arbitration							
1	Delay in resolving disputes	59	41	16	1,2	1,2	
2	Injustice (unfairness)	46	28	21		1,2	
3	Uncertainty due to lack of records or ambiguity of contract	58	61	5		1,2	
4	Cost of obtaining decision	41	47	3	1,2	1,2	
5	Enforcing decisions	44	38	18	1,2	1,2	1,2
6	Changes in statutes	44	33	25	1,2	1,2	1,2

4.8 RISK MANAGEMENT APPROACH

The final objective of this research is to identify and evaluate the risk management approach practiced by local contractor in the current period. Thus the author raised the following questions in the distributed questionnaire.

a) Does your company conduct a risk identification technique on project?
b) If your answer to "a" is other than "Never" what techniques do you employ to identify contract risk?
c) Does your company conduct risk analysis on projects?
d) If your answer to question "c" is other than "Never" what techniques do you employ to analyze contract risk on projects?
e) what risk response approach do you often employ on your project?

I. RISK IDENTIFICATION

In view of that, as shown in Table 4.14 the response of the respondent for the first question states that from the total response given more than a half of the respondent (55% of the respondent) conducted risk identification in 25-50% of their projects. This implies that the risk identification technique applied by Ethiopian contractors of grade one to three are yet to completely include risk identification technique in their project. In addition their identification technique is below average.

According to the second question Table 4.15 presents the technique employed to identify contract risk. As a result based on WAS the respondent ranked experienced person opinion or judgment, document review, assumption analysis, and interview the top four techniques following diagram analysis the last.

Table 4.14 Risk identification on project

No.	Risk identification on project	Number of respondent	Percentage (%)	Cumulative
1	Never	15	0.19	0.19
2	25% of the project	11	0.14	0.34
3	25-50% of the project	16	0.21	0.55
4	50-75% of the project	20	0.26	0.81
5	75-100% of the project	15	0.19	1.00

According to the Chinese construction industry most frequently applied management techniques are “brainstorming” for identifying risks Tang *et al.*(2007). Brainstorming and checklists are recognized as the most popular risk management tools used in the Malaysian construction industry C. S. Goh and H. Abdul-Rahman (2013). In Nigeria the risk identification techniques frequently used by local and foreign contractors and project managers are brainstorming, checklist, Delphi technique, expert judgment O. M. Ogunbayo (2014). Similarly in Iran, "brain-storming sessions" is the most popular method used frequently to identify the risks in large construction projects Tadayon *et al.*(2012). This implies that most of these countries use information gathering techniques (brainstorming), risk register (checklist), and expert judgment in their project. When we compare this with our country practice they have some techniques in common such as information gathering and expert judgment techniques.

In general these result shows that most of the techniques applied, by these countries including Ethiopia, for the identification of risk management issues that belong to construction projects can be classified as subjective techniques. As they are based on perception and reliance on years of experience in the industry rather than on more scientific and objective ways of identifying and analyzing risk issues that are provided by risk management processes.

II. RISK ANALYSIS

Base on the third question regarding risk analysis, Table 4.16 presents the response given by the respondent. As a result from the total response given cumulatively 71% of Ethiopian contractors of class one to three conduct risk analysis on 25-50% of their projects. Thus as discussed earlier the techniques applied by these contractors is below average.

Table 4.15 Techniques employed to identify a contract risk

No.	Risk identification on project		WAS	Rank
1	Document review	Document review	3.16	2
2	Information gathering techniques	Brain storming	2.42	7
		Delphi technique	2.58	5
		Interview	2.88	4
		Root cause analysis	1.88	8
3	Risk register	Risk register	2.45	6
4	Assumption analysis	Assumption analysis	2.91	3

5	Diagramming analysis	Diagramming analysis	1.29	10
6	SWOT analysis	SWOT analysis	1.54	9
7	Experienced person opinion or judgment	Experienced person opinion or judgment	3.50	1

Table 4.16 risk analysis on project

No.	Risk analysis on project	Number of respondent	Percentage (%)	Cumulative
1	Never	19	0.25	0.25
2	25% of the project	14	0.18	0.43
3	25-50% of the project	22	0.29	0.71
4	50-75% of the project	18	0.23	0.95
5	75-100% of the project	4	0.05	1.00

Similarly, Table 4.17 presents the response given on the techniques employed for analyzing contract risk by the respondents. As a result most of the respondent use qualitative risk analysis technique specially by project location, project type, tender document clarity, and construction type. According to the study conducted by other researchers the Chinese construction industry most frequently applied management techniques are “joint evaluation by key participants” in risk analysis, “reducing risks” within risk response strategies, and “periodic document reviews” in risk monitoring Tang *et al.*(2007). The author further states that the qualitative techniques are used much more often than quantitative techniques in the industry. Lithuanian construction companies use qualitative method of risk assessment most frequently a head of quantitative method Banaitiene and Banaitis (2012). Although, qualitative analysis technique is popular in these countries, it is common also in Ethiopia. Thus this survey result aligns with those other studies conducted about risk analysis technique described in the reviewed literature i.e. qualitative method most frequently than quantitative method.

Table 4.17 Techniques employed to analyze contract risk

No.	Techniques to analyze contract risk		WAS	Rank
1	Qualitative analysis	Project type	2.83	2
		Project cost	2.38	6
		Project time/ schedule	2.04	7
		Construction type	2.62	4
		Project location	3.14	1
		Tender document clarity	2.78	3
2	Quantitative analysis	Sensitivity analysis (the tornado diagram)	1.37	9
		Expected monitory analysis (decision tree analysis)	1.43	8
		Modeling & simulation (Monte Carlo simulation)	1.37	9
3	Fuzzy logic	Fuzzy logic	2.44	5

III. RISK RESPONSE

Finally, Table 4.18 presents respondents response on risk response approach on the project. According to previous sections this result also ranked based on WAS. As a result, accept the risk by allocating contingency, transfer the risk through insurance, adjusting profit margin and negotiation when and if the risk occurs to mitigate the risk are the top four risk response approaches identified by the respondent. According to literature reviewed in section 2.6.5 following identification and analysis of project risks, it demands a response to identified project risks. In this regard a strategic approach risk response planning is adopted in many risk management processes. These are : strategies for negative risks or treats, strategies for positive risks or opportunities, contingent response strategies and expert judgment. Thus if we consider the negative strategy, four strategies, which typically deal with threats or risks. that may have negative impacts on project objectives if they occur are: avoid, transfer, mitigate, and accept.

Table 4.18 Risk response approach

No	Risk response approach		WAS	RANK
1	**Mitigate the risk:**	Negotiation when and if the risk occurs.	3.12	4
		Design review contract document analysis before tendering.	2.58	8
		Selecting contracting parties (including consultants) in tender participation.	1.94	11
		Selecting projects by project nature, environment, etc.	2.94	6
		Conducting more tests on a product or service.	1.76	14
		Choosing more stable supplier.	1.87	12
		Adopting less complex process/methodology.	2.05	9
		Stocking supplies.	1.80	13
		Adjusting profit margin.	3.18	3
2	**Transfer the risk:**	Through sub-contracting.	3.00	5
		Through insurance.	3.22	2
3	**Accept the risk:**	Allocating responsible person.	2.74	7
		Allocating contingency.	3.32	1
		Extending or shortening the schedule.	2.03	10

4.9 RISK MANAGEMENT PRACTICE PROMOTION

Olamiwale (2014) cited Khalafallah and Azhar (2004) stated risk management techniques are essentially management techniques used to handle risky situations. On the other hand there are factors limiting to the practical application of risk management in the construction industry. Some of these are:

- Deficiency in the knowledge of risk management techniques.
- Highly sophisticated techniques that are available are unnecessary compared with the size of the project.
- Reservations about the relevance of the available techniques to the construction industry.
- Most of the risks surfaced during the process of construction, and are quite subjective; therefore, they are best handled with experience from past contracts.
- Risk analyses of construction projects are rarely demanded by clients.
- Unavailability of quality data required poses a loss of confidence in risk management techniques.

Thus, the respondent was requested to put their opinion how to improve the risk management practice in the Ethiopian building construction project. As stated in Table 4.19 based on WAS the respondent ranked, respecting the contract document both by the employer and contractor, capacity building in the sector (for example: if low labor competence is a source of risk), implementing proper (principled) risk allocation between contracting parties and others, and improving the contract/tender document (including drawings and specifications) standard (accuracy and intelligibility).

Table 4.19 Opinion of the respondent on promotion of risk management practice

	Risk management practice	WAS	Rank
F	Respecting the contract document both by the employer and contractor.	4.12	1
E	Capacity building in the sector (for example: if low labor competence is a source of risk).	4.08	2
D	Implementing proper (principled) risk allocation between contracting parties and others.	4.01	3
C	Improving the contract/tender document (including drawings and specifications) standard (accuracy and intelligibility).	3.91	4
G	Encouraging collaboration culture environment among involved parties.	3.86	5
I	Incorporating implementation of risk management systems among the strategic objectives of organizations involved in projects.	3.65	6
H	Request for implementation of risk management processes (such as formal risk identification, analysis and response) in projects by employer and contractors in tendering and contract administration.	3.53	7
B	Introduction of risk management standard (risk register, analysis) by government or other agencies before floating tender.	3.47	8
A	Providing training and seminar on risk management.	3.44	9

5. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Based on the findings of the study, the following key conclusion is made;

1. The major risk factors identified by all contractors is almost similar.
2. Compared with the risk management standards all contractors have more work to do to improve the implementation of risk management in their project.
3. When we compare FIDIC (1999) and PPPAA (2011) from contractors perspective, PPPAA allocated price adjustment in the event change in legislation wrongly to the contractor.
4. They need to increase the frequency of use of all risk management approach in their project. (For example, the application of quantitative risk analysis technique as it is lower than that of qualitative risk analysis.)

In regards to the objectives of the study, the following key conclusions are made;

1. Major risks: based on the probability of occurrence, inadequacy of time or finance, late supply of information/ design data/ drawing, defective design, financial constraint, delay in payment, and inflation are identified as the highest ranking risks. In terms of impacts on project performance, inadequacy of finance, exchange rate, delay in settling claim are identified as the highest risk factor based on the level of impact on overall performance, time and cost. Defective design, financial constraints, inflation are also identified as the highest risk factor based on the level of impact on overall performance, time, cost and quality. Similarly, delay in payment and mistakes in document are identified as the highest risk factor based on the level of impact on time, cost, and quality, and impact on time and cost respectively on a project as delivered by the PPPAA's standard bidding document. It can be observed that most of these risk factors cannot be controlled or managed by the contractors. In addition contractors working in this contract is expected to accept inflation, delay in payment and financial constraint. Thus, there is a need of including a reinforcing condition within the construction contract which is designed to solve these risks in legal manner;
2. Allocation of risks amongst the contracting parties; According to the finding in the allocation of risk factors it is observed that the allocation by the respondent and the analysis of the contract documents by the writer is different. However, when we consider

PPPAA it has a deficiency in risk allocation. Thus, this is not in general an indication of a shortage in knowledge and lack of experience in allocating the risk to the required party;

3. Risk management practice: Based on the survey result, contractors investigated, yet to completely include risk identification and analysis technique in their project. In addition, when they conduct these risks management techniques, their risk identification and analysis techniques are below average. The result also shows that most of the techniques for the identification of risk management issues that belong to construction projects can be classified as subjective techniques as they are based on perception and reliance on years of experience in the industry rather than on more scientific and objective ways of identifying and analyzing risk issues that are provided by risk management processes. In addition, they use qualitative risk analysis technique specially by project location, project type, tender document clarity and construction type which is in general a weaker analysis technique as compared to the more rigorous quantitative analysis techniques recommended.
4. Capacity improvement in risks management: Previous discussion indicates that identification and analysis technique applied by the contractors is at low level. In line with this, following identification and analysis of project risks, it demands a response to identified project risks. In this regard, the risk response approach indicated in the findings states that among many response approaches; allocating contingency (accepting), through insurance (transferring), and adjusting profit margin (mitigating) are commonly used approaches. This is an indication of the risk response strategy is at lower level in Ethiopian contractors of class one to three. Therefore, there is a need to improve the capacity of risk management in the industry.

5.2 RECOMMENDATION

From the findings and the conclusions made above, the following recommendations are drawn:

1. Contracts are essential tools for organizing the relationship between different parties involved in the construction project and managing associated risks. Thus, understanding and respecting what is stated in the contract document both by the employer and contractor is necessary. In regarding key risks identified, major finance inadequacy could potentially be improved by increasing the liquidity of the contractors through access to financial institutions (loans, on time payments, etc.), as significant risk factor, inflation

needs to be looked by stakeholders and appropriate compensation mechanism to be put in place to mitigate or compensate the impact of this risk on the financial safety of the contractor, and payment for executed contracts should be organized/processed in a timely manner to support financial stability to contractors. This can help contractors from collapse of their financial resources by using strict and improve cash flow system and reduce the option of reliance on financial institutions loans.

2. Implementing proper (principled) risk allocation between contracting parties and others is important. Therefore, improving the contract/tender document (including drawings and specifications) standard (accuracy and intelligibility) and allocating risks in accordance with accepted risks allocation philosophies is important for proper risks management. In addition, PPPAA should be revised to include issue such as price adjustment in the event change in legislation.
3. Contractors need to develop a risk culture where everybody is involved and understand the importance of the proper implementation of project risk management processes. Proper education and training is a must. Contractors should train their construction professionals and managers, in order to advance risk management approach in the companies and to improve their understanding of the techniques and methods which are indicated in risk management standards. In addition, there is a need to improve the use of both risk analysis techniques especially quantitative technique.
4. This study is limited to the contractors of class one to three, but future research on the topic should take into consideration the client and the project consultant perspective. Such a study, in addition to potentially revealing biases by the parties, might be used as across-analysis purposes to synthesize the outs and draw a more comprehensive assessment of the practice.

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APPENDIX A: QUESTIONNAIRE

QUESTIONNAIRE

Dear Respondents,

This questionnaire is a part of my M.Sc. degree research in Construction Technology and Management at Addis Ababa Science and Technology University; and it is designed to obtain relevant information on my research topic.

Evidence from around the world has shown that construction projects are subject to several risks. Among the various stakeholders, the contractor has been identified to be the party that carry the highest number of risks, including many which originate from parties other than him/herself. However, these studies have not been stereotyped to Ethiopian context and the risks the local contractors are exposed to when contracting is not thoroughly addressed. Therefore, to partially fill this gap, this study aims to investigate "**The building contractor's risk sources associated with the contract's delivered through the PPPAA's standard bidding document."**

So it's with great respect that I ask you to fill and return this questionnaire. I kindly implore you to fill the questionnaire with your at most care and sincerity. I guarantee that your identity will be kept confidential and the information you provide only be used for academic purposes. I will be happy to share the findings of this research when it's completed.

Thank you in advance for taking your precious time to fill this questionnaire. Since, your response will greatly contribute to the growth and advancement of knowledge in the construction industry.

If you have any questions or comments, please don't hesitate to contact me. You can reach me by; **Mobile**: 0911198946; **E-mail**: berhanuzelalem@gmail.com

With Regards,

Zelalem Berhanu

Justification for the research questions raised in the questionnaire

<table>
<tr><th colspan="2">Research question</th><th>Explanation</th></tr>
<tr><td colspan="3">Section A (General information part)</td></tr>
<tr><td colspan="3">Contains the company and respondents profile. It is important for the researcher to get information about the company experience in the construction industry and to categorize and examine their knowledge in contract risk management practice in the building construction project.</td></tr>
<tr><td>1</td><td>Company profile:
1.1. Work experience in the construction industry;
<table><tr><th>Companies experience</th><th>0-5 years</th><th>5-10 years</th><th>>10 years</th></tr><tr><td>In the construction industry</td><td></td><td></td><td></td></tr></table></td><td>Work experience implies the companies have been in the industry long enough to furnish/ supply reliable responses in contract risk management.
Number of years tell us the maturity of the company, researchers classification.</td></tr>
<tr><td></td><td>1.2. Category:
Contractor (BC) ☐ (GC) ☐ Grade 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ and 6 ☐</td><td>Implies to analyze the knowledge of contract risk management practice in each category of contractor's grade 1-6. Other grades are not included.</td></tr>
<tr><td></td><td>1.3. Type of work usually undertaken (note that the delivery system for the project is DBB).
<table><tr><th></th><th colspan="5">Percentage of the project</th></tr><tr><th></th><th>0-10%</th><th>10-30%</th><th>30-50%</th><th>50-70%</th><th>70-100%</th></tr><tr><td>Commercial/industry buildings</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Public/community buildings</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Others please specify (_____)</td><td></td><td></td><td></td><td></td><td></td></tr></table></td><td>Since, the research deals with contract risk management in the DBB contract and to identify the type of work most respondents do under this type of delivery system.</td></tr>
</table>

2	**Respondents profile:** **2.1. Position/Responsibility in the company;** General Manager ☐ Deputy manager ☐ Project manager ☐ peration manger ☐ Office-Engineer ☐ Other please specify_____.	**Position/ responsibility implies to provide bias.** **Informed position to provide sufficient/detail company experience.**
	2.2. Work experience. **Total work experience** | **0-5 years** | **5-10 years** | **>10 years** In the construction industry | | | | Within this company | | |	**To categorize the respondents and their familiarity with contract risk management practice previously and within the company.** **Number of years tell us the maturity of the respondents on contract risk, researchers classification.**

Section B(research question)

As the aim of this research is to explore common contract provisions that form as risks to the contractor. And to explore risks that building contractors are exposed within the PPPAA's 2011 SBD/ under DBB delivery system. Accordingly, section B of the research question is designed to answer the question raised based on the aim of the research in line with the objective of the research. Under this section five main questions are raised as follows.

1	**Please tick the listed construction contract risk on the next table(on page 4) based on their probability of occurrence and impacts on a project.**	**This question is raised to answer the first and second research questions; to identify and evaluate potential risk factors contractors are exposed to while executing a contract under PPPAA's(2011) and their probability of occurrence and impact of contract risk**

Probability of occurrence on a project				
Rare	**Unlikely**	**Possible**	**Likely**	**Almost certain**
< 2%	2-10%	10-50%	50-80%	>80%

Project	**Impact on project**

objectives	Very low	Low	Moderate	High	Very high
Time	< 5% Time/schedule decrease	Insignificant time/schedule increase	< 10% time/schedule increase	10-20% time/ schedule increase	> 20% time/schedule increase
Cost	10% cost decrease	insignificant cost increase	< 10% cost increase	10-30% cost increase	> 30% cost increase
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction requires client approve	Quality reduction unacceptable to the client	Project end item effectively unusable

on three major project objectives (time, cost and quality).

Probability of occurrence, impact on project are preset in section 3.11 please refer for detail.

List of contract risk are identified and listed from the literature review section 2.5 please refer for detail.

	Risk in a construction contract	Probability of occurrence					Impact on																				
							over all project performance					project time					Project cost					Project quality				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
A) Physical works																											
1	Change in ground condition																										
2	Artificial obstacles																										
3	Defective materials or workman ship																										
4	Tests and samples approval (materials provided by contractor)																										
5	Exceptionally inclement weather																										
6	Site preparation																										
7	Inadequacy (insufficient) of staff																										
8	Inadequacy labour																										
9	Inadequacy of plant/equipment																										

10	Inadequacy of material																										
11	Inadequacy of time or finance																										
B) Delay and disputes																											
1	Possession of site																										
2	Late supply of information/ design data/drawing																										
3	Inefficient execution of work																										
4	Delay outside of both parties' control																										
5	Layout (design) dispute																										
C) Direction and supervision																											
1	Greed (insatiability) of supervisor																										
2	Incompetence																										
3	Inefficiency																										
4	Unreasonableness																										
5	Partiality																										
6	Poor communication																										
7	Mistakes in documents																										
8	Defective designs																										
9	Compliance with requirements																										
10	Unclear requirements																										
11	Inappropriate consultants or contractors																										
12	Changes in requirements																										
D) Damage and injury to persons and property																											
1	Negligence or breach of warranty																										
2	Uninsurable matters																										
3	Accidents within the construction site																										
4	Uninsurable risks																										
5	Consequential losses																										
6	Exclusion																										

7	Gaps and time limits in insurance cover																											
E) External factors																												
1	Government policy on taxes																											
2	Labour strike																											
3	Safety or other laws																											
4	Planning approvals																											
5	Financial constraints																											
6	Energy or pay restraints																											
7	Cost of war or civil commotion																											
8	Malicious (hateful) damage																											
9	Intimidation (threats)																											
10	Industrial disputes																											
F) Payment																												
1	Delay in settling claims and certifying																											
2	Delay in payment																											
3	Legal limits on recovery of interest																											
4	Insolvency (bankruptcy)																											
5	Funding constraints																											
6	Shortcomings in the measure and value process																											
7	Exchange rates																											
8	Inflation																											
G) Law and arbitration																												
1	Delay in resolving disputes																											
2	Injustice (unfairness)																											
3	Uncertainty due to lack of records or ambiguity of contract																											
4	Cost of obtaining decision																											
5	Enforcing decisions																											

6	Changes in statutes																										
7	New interpretations of common law																										

2	**Risk management approaches:** **2.1 Does your company conduct a risk identification technique on project? (For example: document, drawing, quantity, and price review).** Never ☐ 25% of the project ☐ 25-50% of the project ☐ 50-75% of the project ☐ 75-100% of the project ☐	Implies to check the companies risk identification techniques. The choose are given by researcher to evaluate the identification techniques in the number of project.

2.2 If your answer to the question 2.1 is "<u>other than Never</u>" what techniques do you employ to identify contract risk? (please tick the actual technique you are using on space provided and <u>multiple answers possible</u>).

	Techniques to identify contract risk	0-25% of the project	25-50% of the project	50-75% of the project	75-100% of the project
1	Document review such as: tender document, drawing, quantity, and price checking).				
2	Information gathering technique				
	2.1 Brain storming				
	2.2 Delphi technique				
	2.3 Interview				
	2.4 Root cause analysis				
	2.5 Others please specify				
3	Check list analysis (based on historical information and knowledge from previous project).				
4	Assumption analysis				
5	Diagramming analysis like cause effect and system flow				
6	SWOT (strength, weakness, opportunity and treat) analysis				
7	Experienced person opinion or judgment				
8	Others please specify_____.				

These questions are raised to the respondents to check the current stage of risk identification practice of the local contractors; to relate with previous studies conducted and also with the literature reviewed.
Techniques to identify contract risk is taken from literature review please refer section 2.6 for detail.

2.3 Does your company conduct risk analysis on projects?

Never ☐ 25% of the project ☐ 25-50% of the project ☐ 50-75% of the project ☐ 75-100% of the project ☐

Implies to check the companies risk analysis techniques.
The choose are given by researcher to evaluate the analysis technique in the number of project.

2.4 If your answer to the question 2.3 is "<u>other than Never</u>" what techniques do you employ to analyze contract risk on project? (please tick the actual technique you are using on space provided and <u>multiple answers possible</u>).

	Techniques to analyze contract risk		0-25% of the project	25-50% of the project	50-75% of the project	75-100% of the project	
	1	**Comparative analysis based on:**					The analysis techniques are adapted from literature review please refer section 2.6.3 and 2.6.4.
		1.1 Project type					
		1.2 Project cost					
		1.3 Project time/ schedule					
		1.4 Construction type					
		1.5 Project location					
		1.6 Tender document clarity					
		1.7 Other please specify_____.					
	2	**Diagram analysis**					
		2.1 Sensitivity analysis (the tornado diagram)					
		2.2 Expected monitory analysis (decision tree analysis)					
		2.3 Modeling & simulation (Monte Carlo simulation)					
		2.4 Others please specify_____.					
	3	**Fuzzy logic** for example: to model the relationships between the characteristics of a project and the potential risk events that may occur, and the associated cost overruns caused by combinations of the project characteristics and risk events.					
	4	**Others please specify** _____.					
3	**From the listed type of risk in a construction contract on the next table please tick appropriately the parties/ sources of these risks in building construction project having an effect on a building contractor. (you can tick on more than one party).**						**Since, the risk borne by the employer**

*** Beyond the control of both parties (for example if a suppliers did not deliver the agreed material for the contractor/client on the scheduled date).**

	Risk in a construction contract	Allocation		
		Client	Contractor	Force measure*
A) Physical works				
1	change in ground condition			
2	artificial obstacles			
3	defective materials or workman ship			
4	tests and samples approval (materials provided by contractor)			
5	exceptionally inclement weather			
6	site preparation			
7	inadequacy (insufficient) of staff			
8	inadequacy labour			
9	inadequacy of plant/ equipment			
10	inadequacy of material			
11	inadequacy of time or finance			
B) Delay and disputes				
1	possession of site			
2	late supply of information/design data/drawings			
3	inefficient execution of work			
4	delay outside of both parties' control			
5	layout (design) dispute			
C) Direction and supervision				
1	greed (insatiability) of supervisor			

and contractor are not limited to those allocated by the contract and also there are some risks beyond the control of both the contractor and the employer. Accordingly, the this question is raised to the respondent to answer the third research question. That is; <u>the allocation of each identified contract risk factors from contractor's perspective.</u>

2	Incompetence				
3	Inefficiency				
4	Unreasonableness				
5	Partiality				
6	poor communication				
7	mistakes in documents				
8	defective designs				
9	compliance with requirements				
10	unclear requirements				
11	inappropriate consultants or contractors				
12	changes in requirements				
D) Damage and injury to persons and property					
1	negligence or breach of warranty				
2	uninsurable matters				
3	accidents within the construction site				
4	uninsurable risks				
5	consequential losses				
6	Exclusions				
7	gaps and time limits in insurance cover				
E) External factors					
1	government policy on taxes				
2	labour strike				
3	safety or other laws				
4	planning approvals				
5	financial constraints				
6	energy or pay restraints				
7	cost of war or civil commotion				
8	malicious (hateful) damage				

	9	intimidation (threats)				
	10	industrial disputes				
	F) Payment					
	1	delay in settling claims and certifying				
	2	delay in payment				
	3	legal limits on recovery of interest				
	4	insolvency (bankruptcy)				
	5	funding constraints				
	6	shortcomings in the measure and value process				
	7	exchange rates				
	8	Inflation				
	G) Law and arbitration					
	1	delay in resolving disputes				
	2	injustice (unfairness)				
	3	uncertainty due to lack of records or ambiguity of contract				
	4	cost of obtaining decision				
	5	enforcing decisions				
	6	changes in statutes				
	7	new interpretations of common law				

4	**What risk response approach do you often employ on your project?** **How do you prevent/ mitigate these risks to the parties involved in a project? (please tick appropriately on the space provided and <u>multiple answers possible</u>).**	Implies to check the companies risk response approach. The choose are given by researcher to

	Risk response approach	0-25% of the project	25-50% of the project	50-75% of the project	75-100% of the project
1	**Mitigate the risk:**				
	1.1 By negotiation when and if the risk occurs.				
	1.2 By design review.				
	1.3 By contract document analysis.				
	1.4 By conducting more tests on a product or service.				
	1.5 By choosing more stable supplier.				
	1.6 By adopting less complex process				
	1.7 Other please specify_____.				
2	**Transfer the risk:**				
	2.1 Through sub-contracting to sub-contractor.				
	2.2 Through insurance to insurance companies.				
	2.3 Others please specify_____.				
3	**Accept the risk:**				
	3.1 By allocating responsible person.				
	3.2 By allocating contingency.				
	3.3 By adjusting profit margin.				
	3.4 By stocking resource.				
	3.5 By extending or shortening the schedule.				
	3.6 Others please specify _____.				

evaluate risk response approach in the number of project.

The response approach are adapted from literature review please refer section 2.6.5.

5

How do you think risk management practice can be promoted in Ethiopian's building construction industry? (please tick on space provided and <u>multiple answers possible</u>). Very low (1), Low (2), Moderate (3), High (4) and Very high (5).

	Risk management practice	1	2	3	4	5
A	Providing training and seminar on risk management.					
B	Introducing courses and program related to/ Inclusion of risk management systems among education and training subjects of construction practitioners.					
C	Introduction of risk management standard by government or other agencies.					
D	Improving the contract standard (accuracy).					
E	Implementing proper risk allocation.					
F	Improving design documents (assuming design is one of the causes).					
G	Capacity building in the sector (for example if law labour competence is a source of risk).					
H	Respecting the contract document both by the employer and contractor.					
I	Encouraging collaboration culture environment among involved parties.					
J	Request for implementation of risk management systems in projects by employer and end users.					
K	Incorporating implementation of risk management systems among the strategic objectives of organizations involved in projects.					
L	Awareness and knowledge of the process for implementing Risk Management					
I	Other please specify_____.					

It will be help full for the researcher to draw a conclusion and recommendation on risk management practice in the building construction industry based on the respondents opinion.

APPENDIX B: PROBABILITY OF OCCURRENCE OF POTENTIAL RISK FACTORS

Probability of occurrence of potential risk factor		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact
A) Physical works													
1	Change in ground condition	2.91	5	possible	3.92	1	likely	3.44	2	possible	3.42	2	Possible
2	Artificial obstacles	2.72	10	possible	3.00	7	possible	2.69	10	possible	2.80	10	Possible
3	Defective materials or workman ship	2.78	9	possible	3.00	7	possible	2.81	9	possible	2.86	9	Possible
4	Tests and samples approval (materials provided by contractor)	2.91	5	possible	3.08	6	possible	3.38	4	possible	3.12	4	Possible
5	Exceptionally inclement weather	2.13	11	unlikely	2.23	11	unlikely	2.00	11	unlikely	2.12	11	Unlikely
6	Site preparation	2.88	8	possible	3.00	7	possible	3.34	5	possible	3.07	6	Possible
7	Inadequacy (insufficient) of staff	3.00	3	possible	2.69	10	possible	3.41	3	possible	3.03	8	Possible
8	Inadequacy labor	2.91	5	possible	3.30	3	possible	3.06	7	possible	3.09	5	Possible
9	Inadequacy of plant/equipment	2.97	4	possible	3.15	4	possible	3.06	7	possible	3.06	7	Possible
10	Inadequacy of material	3.28	2	possible	3.15	4	possible	3.31	6	possible	3.25	3	Possible
11	Inadequacy of time or finance	3.50	1	possible	3.77	2	likely	3.75	1	likely	3.67	1	Likely
B) Delay and disputes													
1	Possession of site	2.91	2	possible	3.38	2	possible	3.16	2	possible	3.15	2	Possible
2	Late supply of information/ design data/drawing	3.41	1	possible	3.69	1	likely	3.69	1	likely	3.60	1	Likely

3	Inefficient execution of work	2.56	4	possible	3.00	3	possible	2.94	4	possible	2.83	3	Possible
4	Delay outside of both parties' control	2.47	5	unlikely	3.00	3	possible	2.41	5	unlikely	2.63	5	Possible
5	Layout (design) dispute	2.63	3	possible	2.62	5	possible	3.09	3	possible	2.78	4	Possible
C) Direction and supervision													
1	Greed (insatiability) of supervisor	2.97	3	possible	2.92	5	possible	3.47	3	possible	3.12	3	Possible
2	Incompetence (luck of skill)	2.97	3	possible	3.08	3	possible	3.16	4	possible	3.07	4	Possible
3	Inefficiency (wastefulness)	2.69	6	possible	2.85	6	possible	3.16	4	possible	2.90	6	Possible
4	Unreasonableness	2.41	11	unlikely	2.23	12	unlikely	2.91	10	possible	2.52	12	Possible
5	Partiality	2.28	12	unlikely	2.54	10	possible	2.91	11	possible	2.58	11	Possible
6	Poor communication	2.44	10	unlikely	2.46	11	unlikely	3.00	8	possible	2.63	9	Possible
7	Mistakes in documents	3.09	2	possible	3.62	2	likely	3.75	2	likely	3.49	2	Possible
8	Defective designs	3.34	1	possible	3.77	1	likely	3.97	1	likely	3.69	1	Likely
9	Compliance with requirements	2.63	7	possible	3.08	3	possible	3.16	4	possible	2.95	5	Possible
10	Unclear requirements	2.47	8	unlikely	2.62	9	possible	2.81	12	possible	2.63	10	Possible
11	Inappropriate consultants or contractors	2.47	8	unlikely	2.77	7	possible	3.09	7	possible	2.78	8	Possible
12	Changes in requirements	2.72	5	possible	2.69	8	possible	2.97	9	possible	2.79	7	Possible
D) Damage and injury to persons and property													
1	Negligence or breach of warranty	2.75	2	possible	2.85	2	possible	2.47	2	unlikely	2.69	2	Possible
2	Uninsurable matters	2.38	4	unlikely	2.38	4	unlikely	2.22	3	unlikely	2.33	4	Unlikely
3	Accidents within the construction site	3.03	1	possible	2.92	1	possible	2.84	1	possible	2.93	1	Possible
4	Uninsurable risks	2.31	7	unlikely	2.08	7	unlikely	2.22	3	unlikely	2.20	7	Unlikely
5	Consequential losses	2.38	4	unlikely	2.15	5	unlikely	2.16	6	unlikely	2.23	5	Unlikely
6	Exclusion (not covered by insurance)	2.34	6	unlikely	2.15	5	unlikely	2.16	6	unlikely	2.22	6	Unlikely
7	Gaps and time limits in insurance cover	2.72	3	possible	2.62	3	possible	2.22	3	unlikely	2.52	3	Possible
E) External factors													
1	Government policy on taxes	2.22	4	unlikely	2.54	4	possible	2.22	4	unlikely	2.33	4	Unlikely
2	Labor strike	2.09	5	unlikely	2.23	5	unlikely	1.75	7	unlikely	2.02	6	Unlikely

3	Safety or other laws	2.09	5	unlikely	2.15	6	unlikely	2.09	5	unlikely	2.11	5	Unlikely
4	Planning approvals	2.97	3	possible	3.08	2	possible	3.13	2	possible	3.06	2	Possible
5	Financial constraints	3.59	1	likely	3.62	1	likely	3.81	1	likely	3.67	1	Likely
6	Energy or pay restraints	3.03	2	possible	2.62	3	possible	2.63	3	possible	2.76	3	Possible
7	Cost of war or civil commotion	1.47	10	rare	1.23	10	rare	1.78	6	unlikely	1.49	10	Rare
8	Malicious (hateful) damage	1.63	9	unlikely	1.46	9	rare	1.53	9	unlikely	1.54	9	Unlikely
9	Intimidation (threats)	1.94	7	unlikely	1.85	7	unlikely	1.53	9	unlikely	1.77	7	Unlikely
10	Industrial disputes	1.84	8	unlikely	1.62	8	unlikely	1.63	8	unlikely	1.69	8	Unlikely
F) Payment													
1	Delay in settling claims and certifying	3.63	3	likely	3.62	3	likely	3.16	5	possible	3.47	3	Possible
2	Delay in payment	4.31	1	likely	4.15	1	likely	4.28	1	likely	4.25	1	Likely
3	Legal limits on recovery of interest	2.81	7	possible	2.85	7	possible	2.97	6	possible	2.88	7	Possible
4	Insolvency (bankruptcy)	2.63	8	possible	2.38	8	unlikely	2.09	8	unlikely	2.37	8	Unlikely
5	Funding constraints	3.34	4	possible	3.31	4	possible	3.53	3	likely	3.39	4	Possible
6	Shortcomings in the measure and value process	2.88	6	possible	3.15	5	possible	2.88	7	possible	2.97	6	Possible
7	Exchange rates	3.03	5	possible	2.92	6	possible	3.38	4	possible	3.11	5	Possible
8	Inflation	3.88	2	likely	3.92	2	likely	3.94	2	likely	3.91	2	Likely
G) Law and arbitration													
1	Delay in resolving disputes	2.38	2	unlikely	2.77	2	possible	3.09	3	possible	2.75	3	Possible
2	Injustice (unfairness)	2.28	4	unlikely	2.77	2	possible	2.84	5	possible	2.63	4	Possible
3	Uncertainty due to lack of records or ambiguity of contract	2.88	1	possible	3.31	1	possible	3.38	1	possible	3.19	1	Possible
4	Cost of obtaining decision	2.38	2	unlikely	2.77	2	possible	3.16	2	possible	2.77	2	Possible
5	Enforcing decisions	2.19	5	unlikely	2.08	6	unlikely	2.94	4	possible	2.40	5	Unlikely
6	Changes in statutes	2.00	6	unlikely	2.15	5	unlikely	2.47	6	unlikely	2.21	6	Unlikely

APPENDIX C: POTENTIAL RISK FACTORS IMPACT ON PERFORMANCE

Impact on overall performance		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact
A) Physical works													
1	Change in ground condition	3.03	6	possible	3.38	4	possible	3.28	5	possible	3.23	5	Possible
2	Artificial obstacles	2.84	8	possible	2.69	10	possible	2.91	9	possible	2.81	10	Possible
3	Defective materials or workman ship	2.78	10	possible	2.77	9	possible	2.84	11	possible	2.80	11	Possible
4	Tests and samples approval (materials provided by contractor)	2.94	7	possible	2.92	6	possible	3.19	7	possible	3.02	7	Possible
5	Exceptionally inclement weather	2.72	11	possible	2.92	6	possible	2.91	9	possible	2.85	9	Possible
6	Site preparation	2.81	9	possible	2.92	6	possible	3.13	8	possible	2.95	8	Possible
7	Inadequacy (insufficient) of staff	3.31	2	possible	2.62	11	possible	3.38	3	possible	3.10	6	Possible
8	Inadequacy labor	3.16	5	possible	3.38	4	possible	3.31	4	possible	3.28	4	Possible
9	Inadequacy of plant/equipment	3.31	2	possible	3.54	2	likely	3.25	6	possible	3.37	3	Possible
10	Inadequacy of material	3.31	2	possible	3.54	2	likely	3.59	2	likely	3.48	2	Possible
11	Inadequacy of time or finance	3.81	1	likely	3.85	1	likely	3.97	1	likely	3.88	1	Likely
B) Delay and disputes													
1	Possession of site	3.00	3	possible	3.38	2	possible	3.19	4	possible	3.19	4	Possible
2	Late supply of information/ design data/drawing	3.22	2	possible	3.31	3	possible	3.69	1	likely	3.40	1	Possible
3	Inefficient execution of work	3.00	3	possible	3.46	1	possible	3.41	3	possible	3.29	2	Possible
4	Delay outside of both parties' control	2.97	5	possible	3.15	4	possible	2.94	5	possible	3.02	5	Possible
5	Layout (design) dispute	3.31	1	possible	3.00	5	possible	3.44	2	possible	3.25	3	Possible
C) Direction and supervision													

1	Greed (insatiability) of supervisor	3.19	5	possible	3.38	3	possible	3.38	4	possible	3.32	4	Possible
2	Incompetence (luck of skill)	3.50	2	possible	3.31	4	possible	3.38	4	possible	3.39	3	Possible
3	Inefficiency (wastefulness)	2.69	11	possible	3.31	4	possible	3.09	8	possible	3.03	8	Possible
4	Unreasonableness	2.75	10	possible	2.46	12	unlikely	2.81	12	possible	2.67	12	Possible
5	Partiality	2.69	11	possible	2.54	11	possible	2.91	11	possible	2.71	11	Possible
6	Poor communication	2.84	9	possible	2.85	10	possible	3.13	6	possible	2.94	10	Possible
7	Mistakes in documents	3.25	3	possible	3.69	2	likely	3.41	3	possible	3.45	2	Possible
8	Defective designs	3.88	1	likely	4.08	1	likely	3.59	1	likely	3.85	1	Likely
9	Compliance with requirements	2.97	7	possible	3.31	4	possible	3.13	6	possible	3.13	6	Possible
10	Unclear requirements	3.22	4	possible	3.08	7	possible	2.97	10	possible	3.09	7	Possible
11	Inappropriate consultants or contractors	3.16	6	possible	3.08	7	possible	3.47	2	possible	3.23	5	Possible
12	Changes in requirements	2.94	8	possible	3.00	9	possible	3.00	9	possible	2.98	9	Possible
D) Damage and injury to persons and property													
1	Negligence or breach of warranty	3.25	1	possible	2.77	1	possible	2.59	2	possible	2.87	2	Possible
2	Uninsurable matters	2.66	4	possible	2.54	5	possible	2.41	5	unlikely	2.53	4	Possible
3	Accidents within the construction site	3.19	2	possible	2.77	1	possible	2.97	1	possible	2.98	1	Possible
4	Uninsurable risks	2.41	6	unlikely	2.38	6	unlikely	2.41	5	unlikely	2.40	6	Unlikely
5	Consequential losses	2.44	5	unlikely	2.62	4	possible	2.47	4	unlikely	2.51	5	Possible
6	Exclusion (not covered by insurance)	2.31	7	unlikely	2.38	6	unlikely	2.38	7	unlikely	2.36	7	Unlikely
7	Gaps and time limits in insurance cover	2.81	3	possible	2.69	3	possible	2.59	2	possible	2.70	3	Possible
E) External factors													
1	Government policy on taxes	3.03	3	possible	3.08	3	possible	2.69	4	possible	2.93	3	Possible
2	Labor strike	2.63	5	possible	2.62	5	possible	2.66	5	possible	2.63	5	Possible
3	Safety or other laws	2.59	6	possible	2.54	6	possible	2.53	6	possible	2.55	6	Possible
4	Planning approvals	3.19	2	possible	3.23	2	possible	3.22	2	possible	3.21	2	Possible

5	Financial constraints	3.81	1	likely	4.00	1	likely	4.03	1	likely	3.95	1	Likely
6	Energy or pay restraints	3.00	4	possible	2.85	4	possible	2.91	3	possible	2.92	4	Possible
7	Cost of war or civil commotion	2.09	10	unlikely	2.08	10	unlikely	2.13	9	unlikely	2.10	10	Unlikely
8	Malicious (hateful) damage	2.59	6	possible	2.15	8	unlikely	1.88	10	unlikely	2.21	9	Unlikely
9	Intimidation (threats)	2.47	8	unlikely	2.15	8	unlikely	2.16	8	unlikely	2.26	8	Unlikely
10	Industrial disputes	2.47	8	unlikely	2.23	7	unlikely	2.28	7	unlikely	2.33	7	Unlikely
F) Payment													
1	Delay in settling claims and certifying	4.03	3	likely	3.92	4	likely	3.53	4	likely	3.83	4	Likely
2	Delay in payment	4.03	3	likely	4.08	2	likely	4.09	2	likely	4.07	2	Likely
3	Legal limits on recovery of interest	2.81	8	possible	2.77	8	possible	3.03	7	possible	2.87	8	Possible
4	Insolvency (bankruptcy)	3.97	5	likely	3.31	6	possible	3.00	8	possible	3.43	6	Possible
5	Funding constraints	3.84	6	likely	3.69	5	likely	3.53	4	likely	3.69	5	Likely
6	Shortcomings in the measure and value process	3.03	7	possible	3.23	7	possible	3.09	6	possible	3.12	7	Possible
7	Exchange rates	4.25	2	likely	4.08	2	likely	3.84	3	likely	4.06	3	Likely
8	Inflation	4.31	1	likely	4.15	1	likely	4.16	1	likely	4.21	1	Likely
G) Law and arbitration													
1	Delay in resolving disputes	3.03	1	possible	3.38	2	possible	3.34	2	possible	3.25	2	Possible
2	Injustice (unfairness)	2.75	4	possible	3.23	3	possible	3.03	4	possible	3.00	4	Possible
3	Uncertainty due to lack of records or ambiguity of contract	3.03	1	possible	3.54	1	likely	3.28	3	possible	3.28	1	Possible
4	Cost of obtaining decision	2.91	3	possible	3.23	3	possible	3.47	1	possible	3.20	3	Possible
5	Enforcing decisions	2.34	6	unlikely	2.69	6	possible	3.00	5	possible	2.68	6	Possible
6	Changes in statutes	2.63	5	possible	3.00	5	possible	2.84	6	possible	2.82	5	Possible

Impact on Time		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact
A) Physical works													
1	Change in ground condition	3.59	2	likely	3.69	3	likely	3.81	3	likely	3.70	2	Likely
2	Artificial obstacles	3.03	8	possible	2.77	8	possible	3.03	11	possible	2.94	9	Possible
3	Defective materials or workman ship	3.00	9	possible	2.62	10	possible	3.16	10	possible	2.92	10	Possible
4	Tests and samples approval (materials provided by contractor)	2.84	11	possible	2.46	11	unlikely	3.34	8	possible	2.88	11	Possible
5	Exceptionally inclement weather	3.19	7	possible	2.92	6	possible	3.25	9	possible	3.12	7	Possible
6	Site preparation	2.88	10	possible	2.85	7	possible	3.38	7	possible	3.03	8	Possible
7	Inadequacy (insufficient) of staff	3.50	4	possible	2.69	9	possible	3.84	2	likely	3.35	6	Possible
8	Inadequacy labor	3.31	6	possible	3.54	4	likely	3.72	4	likely	3.52	4	Likely
9	Inadequacy of plant/equipment	3.59	2	likely	3.31	5	possible	3.44	6	possible	3.45	5	Possible
10	Inadequacy of material	3.47	5	possible	3.85	2	likely	3.56	5	likely	3.63	3	Likely
11	Inadequacy of time or finance	4.06	1	likely	4.31	1	likely	4.19	1	likely	4.19	1	Likely
B) Delay and disputes													
1	Possession of site	3.31	2	possible	3.62	1	likely	3.44	3	possible	3.46	2	Possible
2	Late supply of information/ design data/drawing	3.50	1	possible	3.62	1	likely	3.84	1	likely	3.65	1	Likely
3	Inefficient execution of work	3.09	5	possible	3.54	3	likely	3.41	4	possible	3.35	4	Possible
4	Delay outside of both parties' control	3.16	4	possible	3.15	5	possible	3.06	5	possible	3.12	5	Possible
5	Layout (design) dispute	3.31	2	possible	3.31	4	possible	3.66	2	likely	3.43	3	Possible
C) Direction and supervision													
1	Greed (insatiability) of supervisor	1.00	12	rare	1.00	12	rare	1.00	12	rare	1.00	12	Rare
2	Incompetence (luck of skill)	3.44	4	possible	3.31	3	possible	3.44	3	possible	3.39	3	Possible

3	Inefficiency (wastefulness)	2.88	10	possible	3.15	4	possible	3.13	6	possible	3.05	8	Possible
4	Unreasonableness	2.75	11	possible	2.54	11	possible	3.09	7	possible	2.79	11	Possible
5	Partiality	2.94	9	possible	2.77	10	possible	3.09	7	possible	2.93	10	Possible
6	Poor communication	3.06	5	possible	2.92	9	possible	3.25	5	possible	3.08	6	Possible
7	Mistakes in documents	3.56	2	likely	3.69	2	likely	3.59	2	likely	3.62	2	Likely
8	Defective designs	3.63	1	likely	4.00	1	likely	3.69	1	likely	3.77	1	Likely
9	Compliance with requirements	3.03	7	possible	3.15	4	possible	3.03	11	possible	3.07	7	possible
10	Unclear requirements	3.00	8	possible	3.00	8	possible	3.06	9	possible	3.02	9	possible
11	Inappropriate consultants or contractors	3.50	3	possible	3.08	7	possible	3.44	3	possible	3.34	4	possible
12	Changes in requirements	3.06	5	possible	3.15	4	possible	3.06	9	possible	3.09	5	possible
D) Damage and injury to persons and property													
1	Negligence or breach of warranty	3.06	1	possible	2.69	2	possible	2.84	1	possible	2.87	2	possible
2	Uninsurable matters	2.63	5	possible	2.23	7	unlikely	2.56	4	possible	2.47	5	unlikely
3	Accidents within the construction site	3.06	1	possible	2.92	1	possible	2.81	2	possible	2.93	1	possible
4	Uninsurable risks	2.34	7	unlikely	2.31	5	unlikely	2.56	4	possible	2.40	6	unlikely
5	Consequential losses	2.66	4	possible	2.54	4	possible	2.56	4	possible	2.59	4	possible
6	Exclusion (not covered by insurance)	2.41	6	unlikely	2.31	5	unlikely	2.34	7	unlikely	2.35	7	unlikely
7	Gaps and time limits in insurance cover	2.75	3	possible	2.62	3	possible	2.75	3	possible	2.71	3	possible
E) External factors													
1	Government policy on taxes	2.56	6	possible	2.77	3	possible	2.63	6	possible	2.65	6	possible
2	Labor strike	3.00	3	possible	2.69	4	possible	2.91	3	possible	2.87	3	possible
3	Safety or other laws	2.78	5	possible	2.62	6	possible	2.81	4	possible	2.74	5	possible
4	Planning approvals	3.09	2	possible	3.31	2	possible	3.19	2	possible	3.20	2	possible
5	Financial constraints	3.91	1	likely	4.15	1	likely	4.06	1	likely	4.04	1	likely
6	Energy or pay restraints	3.00	3	possible	2.69	4	possible	2.78	5	possible	2.82	4	possible
7	Cost of war or civil commotion	2.53	8	possible	2.31	8	unlikely	2.28	9	unlikely	2.37	9	unlikely
8	Malicious (hateful) damage	2.56	6	possible	2.38	7	unlikely	2.25	10	unlikely	2.40	8	unlikely

9	Intimidation (threats)	2.47	9	unlikely	2.31	8	unlikely	2.34	8	unlikely	2.37	9	unlikely
10	Industrial disputes	2.47	9	unlikely	2.23	10	unlikely	2.56	7	possible	2.42	7	unlikely
F) Payment													
1	Delay in settling claims and certifying	4.28	2	likely	3.92	3	likely	3.47	5	possible	3.89	4	likely
2	Delay in payment	4.06	3	likely	4.15	2	likely	4.13	2	likely	4.11	2	likely
3	Legal limits on recovery of interest	3.19	8	possible	3.00	8	possible	2.84	8	possible	3.01	8	possible
4	Insolvency (bankruptcy)	3.75	5	likely	3.31	6	possible	3.22	6	possible	3.43	6	possible
5	Funding constraints	3.63	6	likely	3.62	5	likely	3.59	4	likely	3.61	5	likely
6	Shortcomings in the measure and value process	3.28	7	possible	3.31	6	possible	3.13	7	possible	3.24	7	possible
7	Exchange rates	4.06	3	likely	3.92	3	likely	3.88	3	likely	3.95	3	likely
8	Inflation	4.56	1	most likely	4.38	1	likely	4.28	1	likely	4.41	1	likely
G) Law and arbitration													
1	Delay in resolving disputes	3.34	1	possible	3.46	1	possible	3.66	1	likely	3.49	1	possible
2	Injustice (unfairness)	3.00	4	possible	3.15	4	possible	3.03	4	possible	3.06	4	possible
3	Uncertainty due to lack of records or ambiguity of contract	3.06	3	possible	3.31	2	possible	3.34	3	possible	3.24	3	possible
4	Cost of obtaining decision	3.31	2	possible	3.31	2	possible	3.41	2	possible	3.34	2	possible
5	Enforcing decisions	2.38	6	unlikely	2.62	6	possible	2.94	5	possible	2.64	6	possible
6	Changes in statutes	2.69	5	possible	2.92	5	possible	2.72	6	possible	2.78	5	possible

Impact on Cost		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact
A) Physical works													
1	Change in ground condition	3.53	2	likely	3.31	3	possible	3.50	3	possible	3.45	2	possible
2	Artificial obstacles	2.84	9	possible	2.54	8	possible	2.84	10	possible	2.74	9	possible
3	Defective materials or workman ship	3.06	7	possible	2.77	6	possible	3.25	7	possible	3.03	7	possible
4	Tests and samples approval (materials provided by contractor)	2.66	10	possible	2.54	8	possible	3.03	8	possible	2.74	9	possible
5	Exceptionally inclement weather	2.38	11	unlikely	2.38	11	unlikely	2.72	11	possible	2.49	11	unlikely
6	Site preparation	2.94	8	possible	2.62	7	possible	2.97	9	possible	2.84	8	possible
7	Inadequacy (insufficient) of staff	3.22	5	possible	2.54	8	possible	3.66	2	likely	3.14	6	possible
8	Inadequacy labor	3.19	6	possible	3.08	4	possible	3.44	4	possible	3.23	5	possible
9	Inadequacy of plant/equipment	3.44	3	possible	2.92	5	possible	3.41	5	possible	3.26	4	possible
10	Inadequacy of material	3.41	4	possible	3.38	2	possible	3.41	5	possible	3.40	3	possible
11	Inadequacy of time or finance	3.88	1	likely	3.69	1	likely	4.09	1	likely	3.89	1	likely
B) Delay and disputes													
1	Possession of site	2.88	5	possible	3.46	1	possible	3.16	4	possible	3.16	3	possible
2	Late supply of information/ design data/drawing	3.31	1	possible	3.23	3	possible	3.53	1	likely	3.36	1	possible
3	Inefficient execution of work	3.00	3	possible	3.38	2	possible	3.44	2	possible	3.27	2	possible
4	Delay outside of both parties' control	2.91	4	possible	3.00	4	possible	2.78	5	possible	2.90	5	possible
5	Layout (design) dispute	3.06	2	possible	3.00	4	possible	3.38	3	possible	3.15	4	possible
C) Direction and supervision													
1	Greed (insatiability) of supervisor	2.84	10	possible	2.85	9	possible	3.47	3	possible	3.05	7	possible
2	Incompetence (luck of skill)	3.47	3	possible	3.08	4	possible	3.44	4	possible	3.33	3	possible

3	Inefficiency (wastefulness)	2.94	9	possible	3.23	3	possible	3.19	7	possible	3.12	6	possible
4	Unreasonableness	2.69	12	possible	2.46	12	unlikely	3.09	9	possible	2.75	12	possible
5	Partiality	2.75	11	possible	2.62	11	possible	2.91	12	possible	2.76	11	possible
6	Poor communication	3.19	5	possible	2.69	10	possible	3.19	7	possible	3.02	8	possible
7	Mistakes in documents	3.81	2	likely	3.77	2	likely	3.56	2	likely	3.71	2	likely
8	Defective designs	3.88	1	likely	4.00	1	likely	3.66	1	likely	3.84	1	likely
9	Compliance with requirements	3.06	6	possible	3.08	4	possible	3.22	6	possible	3.12	5	possible
10	Unclear requirements	3.00	7	possible	2.92	7	possible	2.94	11	possible	2.95	10	possible
11	Inappropriate consultants or contractors	3.38	4	possible	3.00	6	possible	3.34	5	possible	3.24	4	possible
12	Changes in requirements	3.00	7	possible	2.92	7	possible	3.06	10	possible	3.00	9	possible
D) Damage and injury to persons and property													
1	Negligence or breach of warranty	3.16	2	possible	2.62	3	possible	2.81	2	possible	2.86	2	possible
2	Uninsurable matters	2.66	6	possible	2.31	6	unlikely	2.63	6	possible	2.53	6	possible
3	Accidents within the construction site	3.19	1	possible	2.77	1	possible	2.84	1	possible	2.93	1	possible
4	Uninsurable risks	2.56	7	possible	2.31	6	unlikely	2.69	5	possible	2.52	7	possible
5	Consequential losses	2.84	4	possible	2.46	4	unlikely	2.72	4	possible	2.67	4	possible
6	Exclusion (not covered by insurance)	2.81	5	possible	2.38	5	unlikely	2.47	7	unlikely	2.56	5	possible
7	Gaps and time limits in insurance cover	2.88	3	possible	2.69	2	possible	2.78	3	possible	2.78	3	possible
E) External factors													
1	Government policy on taxes	2.69	8	possible	2.46	8	unlikely	2.84	3	possible	2.66	5	possible
2	Labor strike	2.94	3	possible	2.54	4	possible	2.84	3	possible	2.77	4	possible
3	Safety or other laws	2.75	7	possible	2.54	4	possible	2.63	6	possible	2.64	6	possible
4	Planning approvals	2.94	3	possible	3.00	2	possible	3.06	2	possible	3.00	2	possible
5	Financial constraints	3.88	1	likely	3.77	1	likely	4.00	1	likely	3.88	1	likely
6	Energy or pay restraints	3.06	2	possible	2.85	3	possible	2.72	5	possible	2.88	3	possible
7	Cost of war or civil commotion	2.69	8	possible	2.31	9	unlikely	2.25	9	unlikely	2.42	10	unlikely
8	Malicious (hateful) damage	2.88	5	possible	2.54	4	possible	2.22	10	unlikely	2.54	8	possible

9	Intimidation (threats)	2.88	5	possible	2.54	4	possible	2.31	8	unlikely	2.58	7	possible
10	Industrial disputes	2.56	10	possible	2.23	10	unlikely	2.63	6	possible	2.47	9	unlikely
F) Payment													
1	Delay in settling claims and certifying	4.06	3	likely	3.77	3	likely	3.41	5	possible	3.75	4	likely
2	Delay in payment	4.09	2	likely	3.92	2	likely	4.06	2	likely	4.03	2	likely
3	Legal limits on recovery of interest	3.13	8	possible	2.77	8	possible	2.97	8	possible	2.95	8	possible
4	Insolvency (bankruptcy)	3.94	4	likely	3.38	5	possible	3.13	7	possible	3.48	6	possible
5	Funding constraints	3.47	6	possible	3.38	5	possible	3.72	4	likely	3.52	5	likely
6	Shortcomings in the measure and value process	3.47	6	possible	3.38	5	possible	3.25	6	possible	3.37	7	possible
7	Exchange rates	3.91	5	likely	3.77	3	likely	3.97	3	likely	3.88	3	likely
8	Inflation	4.38	1	likely	4.08	1	likely	4.44	1	likely	4.30	1	likely
G) Law and arbitration													
1	Delay in resolving disputes	2.88	3	possible	3.23	1	possible	3.53	1	likely	3.21	2	possible
2	Injustice (unfairness)	2.84	4	possible	3.15	3	possible	3.00	5	possible	3.00	4	possible
3	Uncertainty due to lack of records or ambiguity of contract	3.16	2	possible	3.15	3	possible	3.28	3	possible	3.20	3	possible
4	Cost of obtaining decision	3.34	1	possible	3.23	1	possible	3.53	1	likely	3.37	1	possible
5	Enforcing decisions	2.69	6	possible	2.77	6	possible	3.19	4	possible	2.88	5	possible
6	Changes in statutes	2.78	5	possible	2.92	5	possible	2.94	6	possible	2.88	6	possible

Impact on quality		Class 3 GC/BC			Class 2 GC/BC			Class 1 GC/BC			Combined		
Risk in a construction contract		W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact	W.A.S	Rank	Level of impact
A) Physical works													
1	Change in ground condition	1.59	11	unlikely	2.62	7	possible	1.72	10	unlikely	1.98	10	unlikely
2	Artificial obstacles	1.66	10	unlikely	2.23	10	unlikely	1.53	11	unlikely	1.81	11	unlikely
3	Defective materials or workman ship	3.50	1	possible	3.38	4	possible	3.47	2	possible	3.45	1	possible
4	Tests and samples approval (materials provided by contractor)	3.06	5	possible	2.54	9	possible	3.09	6	possible	2.90	7	possible
5	Exceptionally inclement weather	2.13	9	unlikely	2.08	11	unlikely	2.55	8	possible	2.25	9	unlikely
6	Site preparation	2.47	8	unlikely	2.62	7	possible	2.09	9	unlikely	2.39	8	unlikely
7	Inadequacy (insufficient) of staff	3.25	3	possible	2.85	6	possible	3.53	1	likely	3.21	6	possible
8	Inadequacy labor	3.03	7	possible	3.46	1	possible	3.38	3	possible	3.29	3	possible
9	Inadequacy of plant/equipment	3.44	2	possible	3.31	5	possible	3.25	5	possible	3.33	2	possible
10	Inadequacy of material	3.22	4	possible	3.46	1	possible	3.09	6	possible	3.26	5	possible
11	Inadequacy of time or finance	3.06	5	possible	3.46	1	possible	3.28	4	possible	3.27	4	possible
B) Delay and disputes													
1	Possession of site	1.59	5	unlikely	2.46	4	unlikely	1.88	5	unlikely	1.98	5	unlikely
2	Late supply of information/ design data/drawing	2.41	4	unlikely	2.69	3	possible	2.63	2	possible	2.57	3	possible
3	Inefficient execution of work	2.88	1	possible	3.54	1	likely	3.22	1	possible	3.21	1	possible
4	Delay outside of both parties' control	2.53	2	possible	2.46	4	unlikely	2.19	4	unlikely	2.39	4	unlikely
5	Layout (design) dispute	2.50	3	unlikely	2.92	2	possible	2.56	3	possible	2.66	2	possible
C) Direction and supervision													
1	Greed (insatiability) of supervisor	3.00	6	possible	2.85	7	possible	3.00	6	possible	2.95	6	possible
2	Incompetence (luck of skill)	3.59	1	likely	3.31	3	possible	3.31	3	possible	3.40	2	possible

3	Inefficiency (wastefulness)	2.66	9	possible	2.85	7	possible	3.09	4	possible	2.87	7	possible
4	Unreasonableness	2.66	9	possible	2.31	11	unlikely	2.72	11	possible	2.56	11	possible
5	Partiality	2.63	11	possible	2.23	12	unlikely	2.53	12	possible	2.46	12	unlikely
6	Poor communication	2.94	7	possible	2.54	10	possible	2.78	10	possible	2.75	10	possible
7	Mistakes in documents	3.44	4	possible	3.38	2	possible	3.06	5	possible	3.29	4	possible
8	Defective designs	3.53	2	likely	3.92	1	likely	3.53	1	likely	3.66	1	likely
9	Compliance with requirements	3.06	5	possible	3.00	4	possible	3.00	6	possible	3.02	5	possible
10	Unclear requirements	2.91	8	possible	2.69	9	possible	2.84	8	possible	2.81	8	possible
11	Inappropriate consultants or contractors	3.47	3	possible	3.00	4	possible	3.44	2	possible	3.30	3	possible
12	Changes in requirements	2.59	12	possible	2.92	6	possible	2.84	8	possible	2.79	9	possible
D) Damage and injury to persons and property													
1	Negligence or breach of warranty	2.34	2	unlikely	2.31	1	unlikely	2.38	1	unlikely	2.34	1	unlikely
2	Uninsurable matters	2.09	5	unlikely	1.85	5	unlikely	2.00	4	unlikely	1.98	5	unlikely
3	Accidents within the construction site	2.25	3	unlikely	1.92	3	unlikely	2.25	2	unlikely	2.14	3	unlikely
4	Uninsurable risks	1.81	7	unlikely	1.77	7	unlikely	1.75	7	unlikely	1.78	7	unlikely
5	Consequential losses	2.44	1	unlikely	2.15	2	unlikely	1.97	5	unlikely	2.19	2	unlikely
6	Exclusion (not covered by insurance)	1.97	6	unlikely	1.85	5	unlikely	1.81	6	unlikely	1.88	6	unlikely
7	Gaps and time limits in insurance cover	2.19	4	unlikely	1.92	3	unlikely	2.03	3	unlikely	2.05	4	unlikely
E) External factors													
1	Government policy on taxes	1.91	10	unlikely	2.23	4	unlikely	1.81	9	unlikely	1.98	9	unlikely
2	Labor strike	2.25	6	unlikely	2.38	3	unlikely	2.44	2	unlikely	2.36	3	unlikely
3	Safety or other laws	2.16	7	unlikely	2.00	8	unlikely	2.13	5	unlikely	2.09	6	unlikely
4	Planning approvals	2.38	2	unlikely	2.46	2	unlikely	2.31	3	unlikely	2.38	2	unlikely
5	Financial constraints	3.44	1	possible	3.69	1	likely	3.44	1	possible	3.52	1	likely
6	Energy or pay restraints	2.03	9	unlikely	1.92	10	unlikely	1.84	7	unlikely	1.93	10	unlikely
7	Cost of war or civil commotion	2.31	4	unlikely	2.15	6	unlikely	1.84	7	unlikely	2.10	5	unlikely
8	Malicious (hateful) damage	2.28	5	unlikely	2.08	7	unlikely	1.72	10	unlikely	2.03	7	unlikely

9	Intimidation (threats)	2.13	8	unlikely	2.00	8	unlikely	1.91	6	unlikely	2.01	8	unlikely
10	Industrial disputes	2.34	3	unlikely	2.23	4	unlikely	2.22	4	unlikely	2.26	4	unlikely
F) Payment													
1	Delay in settling claims and certifying	4.06	3	likely	3.31	3	possible	2.47	6	unlikely	3.28	4	possible
2	Delay in payment	4.09	2	likely	3.54	1	likely	3.25	2	possible	3.63	2	likely
3	Legal limits on recovery of interest	3.13	8	possible	2.31	8	unlikely	2.31	7	unlikely	2.58	8	possible
4	Insolvency (bankruptcy)	3.94	4	likely	3.00	6	possible	2.66	5	possible	3.20	6	possible
5	Funding constraints	3.47	6	possible	3.31	3	possible	3.03	3	possible	3.27	5	possible
6	Shortcomings in the measure and value process	3.47	6	possible	2.62	7	possible	2.13	8	unlikely	2.74	7	possible
7	Exchange rates	3.91	5	likely	3.31	3	possible	2.94	4	possible	3.38	3	possible
8	Inflation	4.38	1	likely	3.46	2	possible	3.53	1	likely	3.79	1	likely
G) Law and arbitration													
1	Delay in resolving disputes	2.88	3	possible	3.00	1	possible	2.34	4	unlikely	2.74	1	possible
2	Injustice (unfairness)	2.84	4	possible	2.92	2	possible	2.34	4	unlikely	2.70	3	possible
3	Uncertainty due to lack of records or ambiguity of contract	3.16	2	possible	2.23	5	unlikely	2.44	2	unlikely	2.61	5	possible
4	Cost of obtaining decision	3.34	1	possible	2.46	4	unlikely	2.19	6	unlikely	2.66	4	possible
5	Enforcing decisions	2.69	6	possible	2.23	5	unlikely	2.41	3	unlikely	2.44	6	unlikely
6	Changes in statutes	2.78	5	possible	2.85	3	possible	2.50	1	unlikely	2.71	2	possible

APPENDIX D: ALLOCATION OF RISK IN BUILDING CONTRACT UNDER FIDIC AND PPPAA

Risk in a construction contract		Contract clauses addressed under		Common allocation of risks in building construction contract for the parties having an effect on building contractors under FIDIC 1999 and PPPAA 2011		
		FIDIC 1999	**PPPAA's 2011**	**Client**	**Contractor**	**Force majeure**
A) Physical works						
1	Change in ground condition	4.12 Unforeseeable physical condition, 13.1 Right to vary.	15.Modifications by change orders, 44. Exceptional risks, 65. Final statement of account, 69.Claims for additional payment, 73. Extension of intended completion date.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
2	Artificial obstacles	4.12 Unforeseeable physical condition, 4.13 Rights of way facilities, 4.14 Avoidance of interference, 4.23 Contractor's operation on site, 4.24 Fossils.	44.Exceptional risks, 48.Cables and conduits, 65. Final statement of account, 69.Claims for additional payment, 73. Extension of intended completion date.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
3	Defective materials or workman ship	4.1 Contractor's general obligation, 7.1 Manner of execution, 7.2 Samples, 7.5 Rejection, 7.6 Remedial work, 15.1 Notice to correct.	34. General obligations (contractor), 38. Personnel, 42.Contractor's drawings, 65. Final statement of account, 80. Origin and quality of works and materials, 81. Inspection and testing, 82. Rejection, 85. Tests on completion.		FIDIC 1999/ PPPAA'S 2011	
4	Tests and	4.1 Contractor's general obligation,	34. General obligations (contractor),			

	samples approval (materials provided by contractor)	7.2 Samples, 7.3 Inspection, 7.4 Testing, 7.5 Rejection, 7.6 Remedial work.	42. Contractor's drawings, 80. Origin and quality of works and materials, 81. Inspection and testing, 82. Rejection.		FIDIC 1999/ PPPAA'S 2011	
5	Exceptionally inclement weather	8.4 Extension of time for completion, 19.4 Consequence of force majeure.	18. Force Majeure, 44. Exceptional Risks, 69.Claims for Additional Payment, 73. Extension of Intended Completion Date.			FIDIC 1999/ PPPAA'S 2011
6	Site preparation	4.1 Contractor's general obligation, 4.7 Setting out, 4.15 Accesses route, 4.22 Security of the site.	34. General obligations (contractor), 41. Program of implementation of tasks, 46. Safeguarding adjacent properties, 49. Setting-out of the works, 70. Scope of the work.		FIDIC 1999/ PPPAA'S 2011	
7	Inadequacy (insufficient) of staff	4.1 Contractor's general obligation, 5.2 Objection of nomination, 6.1 Engagement of staff and labour. 7.3 Inspection, 8.6 Rate of progress, 8.7 Delay damage, 11.2 Cost of remedying defect, 14.6 Issue of interim payment certificate.	27. Liquidated damages, 34. General obligations (contractor), 37. Control and supervision of the works, 38. Personnel, 70. Scope of the work, 78. Delays in implementation of tasks.		FIDIC 1999/ PPPAA'S 2011	
8	Inadequacy labor	4.1 Contractor's general obligation, 5.2 Objection of nomination, 6.1 Engagement of staff and labour. 7.3 Inspection, 8.6 Rate of progress, 8.7 Delay damage,	27. Liquidated damages, 34. General obligations (contractor), 37. Control and supervision of the works, 38. Personnel, 70. Scope of the work, 78. Delays in implementation of tasks.		FIDIC 1999/ PPPAA'S 2011	

		11.2 Cost of remedying defect, 14.6 Issue of interim payment certificate.				
9	Inadequacy of plant/ equipment	4.1 Contractor's general obligation, 5.2 Objection of nomination, 7.3 Inspection, 8.6 Rate of progress, 8.7 Delay damage, 11.2 Cost of remedying defect, 14.6 Issue of interim payment certificate.	27. Liquidated damages, 34. General obligations (contractor), 37. Control and supervision of the works, 38. Personnel, 70. Scope of the work, 78. Delays in implementation of tasks.		FIDIC 1999/ PPPAA'S 2011	
10	Inadequacy of material	4.1 Contractor's general obligation, 5.2 Objection of nomination, 7.3 Inspection, 8.6 Rate of progress, 8.7 Delay damage, 11.2 Cost of remedying defect, 14.6 Issue of interim payment certificate.	27. Liquidated damages, 34. General obligations (contractor), 37. Control and supervision of the works, 38. Personnel, 70. Scope of the work, 78. Delays in implementation of tasks.		FIDIC 1999/ PPPAA'S 2011	
11	Inadequacy of time or finance	2.4 Employer's financial arrangement, 4.1 Contractor's general obligation, 4.2 Performance security, 5.2 Objection of nomination, 8.6 Rate of progress, 8.7 Delay damage, 11.2 Cost of remedying defect, 14.6 Issue of interim payment certificate.	27. Liquidated Damages, 34. General Obligations (contractor), 38. Personnel, 41. Program of Implementation of Tasks, 58. Performance Security, 70. Scope of the work, 78. Delays in Implementation of Tasks.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	

B) Delay and disputes						
1	Possession of site	2.1 Right of access to the site, 4.13 Rights of way and facilities, 4.15 Access route, 8.1 Commencement of the work.	31. Access to the site (obligation of the public body), 69. Claims for additional payment, 71. Commencement of works, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
2	Late supply of information/ design data/drawings	1.9 Delayed drawings and instructions, 4.1 Contractor's general obligation, 4.10 Site data, 7.3 inspection.	41. Program of implementation of tasks, 42. Contractor's drawings, 69. Claims for additional payment, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
3	Inefficient execution of work	4.1 Contractor's general obligation, 4.4 Subcontractors, 7.1 Manner of execution, 7.5 Rejection.	14. Subcontracting, 19. Breach of contract, 27. Liquidated damages, 34. General obligations(contractor), 49. Setting-out of the works, 70. Scope of works, 78. Delays in implementation of tasks.		FIDIC 1999/ PPPAA'S 2011	
4	Delay outside of both parties' control	8.5 Delay caused by Authorities, 13.7 Adjustments for changes in legislation, 19.1 Definition of force majeure, 19.4 Consequence of force measure.	18. Force majeure, 21. Termination, 44. Exceptional risks, 73. Extension of intended completion date.			FIDIC 1999/ PPPAA'S 2011
5	Layout (design) dispute	4.7 Setting out, 4.10 Site data, 20.1 Contractor's claim	15. Modifications by change orders, 49. Setting-out of the works, 73. Extension of intended completion date.	FIDIC 1999/ PPPAA'S 2011		

C) Direction and supervision						
1	Greed (insatiability) of supervisor	3.1 Engineer's duties and authority, 3.3 Instruction of the engineer, 4.1 Contractor's general obligation, 8.9 Consequence of suspension.	12. Engineer and engineer's representative, 34. General obligations (contractor), 64. Interim payment, 73. Extension of intended completion date, 74. Compensation events for allowing time extension, 82. Rejection.		FIDIC 1999/ PPPAA'S 2011	
2	Incompetence	3.2 Delegation by the engineer, 3.4 Replacement of the engineer, 6.9 Contractor's personnel, 7.4 Testing.	12. Engineer and engineer's representative, 14. Subcontracting, 37.Control and supervision of the works, 38. Personnel, 74. Compensation events for allowing time extension, 82. Rejection.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
3	Inefficiency	1.9 Delayed drawings and instructions, 3.3 Instruction of the engineer, 3.4 Replacement of the engineer, 6.9 Contractor's personnel.	4. Due diligence, 12. Engineer and engineer's representative, 14. Subcontracting, 37.Control and supervision of the works, 38. Personnel, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
4	Unreasonable ness	3.2 Delegation by the engineer, 3.3 Instruction of the engineer, 3.4 Replacement of the engineer, 3.5 Determination.	12. Engineer and engineer's representative, 20. Suspension, 37.Control and supervision of the works, 54. Overlapping contracts, 65. Final statement of account, 69. Claims for additional payment, 74. Compensation events for allowing time extension,	FIDIC 1999/ PPPAA'S 2011	PPPAA'S 2011	

			82. Rejection.			
5	Partiality	3.1 Engineer's duties and authority, 3.5 Determination.	12. Engineer and engineer's representative, 20. Suspension, 54. Overlapping contracts , 69. Claims for additional payment.	FIDIC 1999/ PPPAA'S 2011		
6	Poor communicatio n	1.3 Communication, 3.4 Replacement of the engineer, 4.3 Contractor's representative, 6.10 Recorders of contractor's personnel and equipment, 7.4 Testing.	3. Relationship between the parties 12. Engineer and engineer's representative, 74. Compensation events for allowing time extension, 76. Management meetings, 79. Work register, 81. Inspection and testing.	PPPAA'S2011	FIDIC 1999/ PPPAA'S 2011	
7	Mistakes in documents	1.5 Priority of documents, 1.9 Delayed drawings and instructions.	59. General principles (payment to the contractor) , 63. Valuation of works.	FIDIC1999	FIDIC 1999/ PPPAA'S 2011	
8	Defective designs	8.4 Extension of time for completion, 20.1 Contractor's claim,	69. Claims for additional payment, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011		
9	Compliance with requirements	3.1 Engineer's duties and authority, 3.4 Replacement of the engineer, 4.1 Contractor's general obligation, 4.3 Contractor's representative, 4.9 Quality assurance, 7.4 Testing. 7.6 Remedial works, 13.1 Right to vary.	4. Due Diligence, 5. Fraud and Corruption, 6. Interpretation, 14. Subcontracting, 16. Change in Laws and Regulations, 21. Termination, 28. Confidentiality, 37. Control and Supervision of the Works, 55. Patents and Licenses, 69. Claims for additional payment, 78. Delays in Implementation of Tasks.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	PPPAA'S 2011

10	Unclear requirements	3.1 Engineer's duties and authority, 3.4 Replacement of the engineer, 4.1 Contractor's general obligation, 4.3 Contractor's representative, 4.9 Quality assurance, 7.6 Remedial works, 13.1 Right to vary.	6. Interpretation, 12. Engineer and engineer's representative, 16. Change in Laws and Regulations, 21. Termination, 29. Miscellaneous, 37. Control and Supervision of the Works, 78. Delays in Implementation of Tasks.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	PPPAA'S 2011
11	Inappropriate consultants or contractors	3.1 Engineer's duties and authority, 3.4 Replacement of the engineer, 4.1 Contractor's general obligation, 4.3 Contractor's representative, 5.2 Objection to nomination, 6.9 Contractor's personnel.	12. Engineer and engineer's representative, 14. Subcontracting, 38. Personnel, 73. Extension of intended completion date, 78. Delays in Implementation of Tasks, 82. Rejection.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
12	Changes in requirements	1.5 Priority of documents, 3.1 Engineer's duties and authority, 3.4 Replacement of the engineer, 4.1 Contractor's general obligation, 4.3 Contractor's representative, 4.9 Quality assurance, 7.4 Testing. 7.6 Remedial works, 13.1 Right to vary, 13.7 Adjustments for changes in legislation.	6. Interpretation, 16. Change in Laws and Regulations, 21. Termination, 28. Confidentiality, 34. General Obligations(contractor's), 37. Control and Supervision of the Works, 69. Claims for additional payment, 78. Delays in Implementation of Tasks.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	PPPAA'S 2011
D) Damage and injury to persons and property						
1	Negligence or breach of warranty	2.3 Employer's personnel, 4.1 Contractor's general obligation, 4.8 Safety procedures, 6.7 Health and safety, 8.7 Delay and damages, 17.1 Indemnities,	19. Breach of contract, 20. Suspension, 21. Termination, 34. General obligations (contractor's), 39. Indemnification and limitation of liability, 40. Insurance to be taken out by the contractor,	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	

		18.1 General requirements for insurances, 18.2 Insurance for works and contractor's equipment, 18.3 Insurance against injury to persons and damage to property, 18.4 Insurance for contractors personnel.	45. Health and safety on sites, 64. Interim Payment.			
2	Uninsurable matters	2.3 Employer's personnel, 4.1 Contractor's general obligation, 17.1 Indemnities, 18.2 Insurance for works and contractor's equipment, 18.3 Insurance against injury to persons and damage to property, 18.4 Insurance for contractors personnel.	34. General obligations(contractor's), 39. Indemnification and limitation of liability, 40. Insurance to be taken out by the contractor, 45. Health and safety on sites, 64. Interim payment.	FIDIC 1999	FIDIC 1999/ PPPAA'S 2011	
3	Accidents within the construction site	2.3 Employer's personnel, 4.1 Contractor's general obligation, 4.8 Safety procedures, 6.4 Labour laws, 6.7 Health and safety, 17.1 Indemnities, 18.2 Insurance for works and contractor's equipment, 18.3 Insurance against injury to persons and damage to property, 18.4 Insurance for contractors personnel.	34. General obligations (contractor's), 39. Indemnification and limitation of liability, 40. Insurance to be taken out by the contractor, 45. Health and safety on sites,	FIDIC 1999	FIDIC 1999/ PPPAA'S 2011	
4	Uninsurable risks	4.1 Contractor's general obligation, 4.8 Safety procedures,	15. Modifications by change orders, 18. Force majeure,	FIDIC 1999/	FIDIC 1999/	

		4.16 Transport of goods, 18.2 Insurance for works and contractor's equipment, 18.3 Insurance against injury to persons and damage to property, 18.4 Insurance for contractors personnel.	34. General obligations (contractor's), 39. Indemnification and limitation of liability, 40. Insurance to be taken out by the contractor, 45. Health and safety on sites, 64. Interim payment.	PPPAA'S 2011	PPPAA'S 2011	
5	Consequential losses	4.1 Contractor's general obligation, 4.8 Safety procedures, 6.7 Health and safety, 18.2 Insurance for works and contractor's equipment, 18.3 Insurance against injury to persons and damage to property, 18.4 Insurance for contractors personnel.	18. Force majeure, 34. General obligations (contractor's), 39. Indemnification and limitation of liability, 40. Insurance to be taken out by the contractor, 45. Health and safety on sites, 64. Interim payment.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
6	Exclusions (not covered by insurance)	4.1 Contractor's general obligation, 4.8 Safety procedures, 4.16 Transport of goods, 6.7 Health and safety, 17.2 Contractor's care of the works, 18.2 Insurance for works and contractor's equipment, 18.3 Insurance against injury to persons and damage to property, 18.4 Insurance for contractors personnel.	18. Force majeure, 34. General obligations (contractor's), 39. Indemnification and limitation of liability, 40. Insurance to be taken out by the contractor, 45. Health and safety on sites, 64. Interim payment.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
7	Gaps and time limits in insurance	2.3 Employer's personnel, 4.1 Contractor's general obligation, 17.2 Contractor's care of the works,	21. Termination, 34. General obligations (contractor's), 39. Indemnification and limitation of liability,	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S	

	cover	18.2 Insurance for works and contractor's equipment, 18.3 Insurance against injury to persons and damage to property, 18.4 Insurance for contractors personnel.	40. Insurance to be taken out by the contractor, 45. Health and safety on sites, 58. Performance security 64. Interim payment.		2011	
E) External factors						
1	Government policy on taxes	4.16 Transport of goods, 13.7 Adjustments for changes in legislation.	16. Change in laws and regulations, 17. Taxes and duties,		FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011
2	Labour strike	6.11 Disorderly conduct, 19.1 Definition of force majeure.	73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
3	Safety or other laws	1.13 Compliance with laws, 2.3 Employer's personnel, 4.8 Safety procedures, 4.18 Protection of the environment, 6.4 Labour laws, 6.5 Working hours, 13.7 Adjustments for changes in legislation.	5. Fraud and corruption, 8. Governing law, 34. General obligations (contractor), 38. Personnel, 45. Health and safety on sites, 46. Safeguarding adjacent properties, 51. Discoveries, 56. Accounting, inspection and auditing, 57. Data protection.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
4	Planning approvals	7.4 Testing, 8.3 Program, 8.5 Delay caused by Authorities, 8.6 Rate of progress.	15. Modifications by change orders, 41. Program of implementation of tasks, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011		
5	Financial constraints	5.2 Objection of nomination, 8.6 Rate of progress, 15.2 Termination by employer,	18. Force majeure, 21. Termination, 73. Extension of intended completion date,	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S	

		16.2 Termination by contractor.			2011	
6	Energy or pay restraints	2.5 Employer's claim, 4.19 Electricity, water and gas, 4.20 Employer's equipment and free issue material,	17. Taxes and duties, 65. Final statement of account.		FIDIC 1999/ PPPAA'S 2011	
7	Cost of war or civil commotion	17.3 Employer's risks, 17.4 Consequences of employer's risk, 19.1 Definition of force majeure, 19.4 Consequences of force majeure.	18. Force majeure, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011		
8	Malicious (hateful) damage	4.22 Security of the site, 6.11 Disorderly conduct, 17.3 Employer's risks, 17.4 Consequences of employer's risk, 19.4 Consequences of force majeure.	18. Force majeure, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011		
9	Intimidation (threats)	6.11 Disorderly conduct, 17.3 Employer's risks, 19.1 Definition of force majeure, 19.4 Consequences of force majeure.	18. Force majeure, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011		
10	Industrial disputes	6.11 Disorderly conduct, 17.5 Intellectual and industrial property right.	55. Patents and licenses, 66. Direct payments to sub-contractors.		FIDIC 1999/ PPPAA'S 2011	
F) Payment						
1	Delay in settling claims	4.7 Setting out, 4.12 Unforeseeable physical	15. Modifications by change orders, 59. General principles (payment to the			

	and certifying	conditions, 7.6 Remedial works, 8.6 Rate of progress, 10.2 Taking over of parts of the works, 10.3 Interference with tests on completion, 12.4 Omissions.	contractor), 65. Final statement of account, 66. Direct payments to sub-contractors, 69. Claims for additional payment.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
2	Delay in payment	5.3 Payment to nominated subcontractors, 5.4 Evidence of payments, 8.6 Rate of progress, 10.2 Taking over of parts of the works, 10.3 Interference with tests on completion, 14.8 Delayed payment, 14.9 Payment of retention money, 16.1 Contractor's entitlement to suspend work.	21. Termination, 32. Payment (obligation of the public body), 59. General principles (payment to the general contractor), 65. Final statement of account, 66. Direct payments to sub-contractors, 67. Delayed payments, 69. Claims for additional payment, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
3	Legal limits on recovery of interest	14.8 Delayed payment.	59. General Principles (payment to the general contractor), 67. Delayed Payments.	FIDIC 1999/ PPPAA'S 2011	PPPAA'S 2011	
4	Insolvency (bankruptcy)	15.2 Termination by employer, 16.2 Termination by contractor.	21. Termination, 27. Liquidated damages, 69. Claims for additional payment, 73. Extension of intended completion date.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
5	Funding constraints	2.4 Employer's financial arrangement,	21. Termination, 27. Liquidated damages,			

		15.2 Termination by employer, 16.2 Termination by contractor.	73. Extension of intended completion date.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
6	Shortcomings in the measure and value process	4.12 Unforeseeable physical conditions, 7.4 Testing, 12.2 Method of measurement, 12.3 Evaluation, 13.1 Right to vary, 13.2 Value engineering, 14.11 Application of final payment certificate.	15. Modifications by change orders, 63. Valuation of works, 65. Final statement of account.		FIDIC 1999/ PPPAA'S 2011	
7	Exchange rates	13.7 Adjustments for changes in legislation, 13.8 Adjustments for changes in cost, 14.5 Plants and materials intended for the works.	16. Change in laws and regulations, 59. General principles (payment to the general contractor), 62. Price adjustments.	FIDIC 1999	PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011
8	Inflation	13.7 Adjustments for changes in legislation, 13.8 Adjustments for changes in cost, 14.5 Plants and materials intended for the works.	16. Change in laws and regulations, 62. Price adjustments, 65. Final statement of account, 69. Claims for additional payment.	FIDIC 1999	PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011
G) Law and arbitration						
1	Delay in resolving disputes	4.7 Setting out, 7.4 Testing, 8.4 Extension of time for completion, 10.2 Taking over of parts of the works,	4. Due diligence, 20.Suspension, 26. Settlement of disputes, 73. Extension of intended completion date, 74. Compensation events for allowing time extension.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S	

		10.3 Interference with tests on completion, 16.1 Contractor's entitlement to suspend work.			2011	
2	Injustice (unfairness)	20.6 Arbitration.	20.Suspension, 21. Termination, 64. Interim payment, 65.Final statement of account.		FIDIC 1999/ PPPAA'S 2011	
3	Uncertainty due to lack of records or ambiguity of contract	4.1 Contractor's general obligation, 4.7 Setting out, 14.11 Application of final payment certificate.	15.Modifications by change orders, 25. Cessation of works, 63. Valuation of works, 65.Final statement of account.		FIDIC 1999/ PPPAA'S 2011	
4	Cost of obtaining decision	4.7 Setting out, 4.12 Unforeseeable physical conditions, 7.4 Testing, 8.4 Extension of time for completion, 10.2 Taking over of parts of the works, 10.3 Interference with tests on completion.	19. Breach of contract, 20. Suspension, 39. Indemnification and limitation of liability.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	
5	Enforcing decisions	13.7 Adjustments for changes in legislation, 15.2 Termination by employer, 16.2 Termination by contractor.	5. Fraud and corruption, 16. Change in laws and regulations, 58. Performance security, 59. General principles (payment to the general contractor), 62. Price adjustments,	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011

			66. Direct payments to sub-contractors, 72. Period of execution of works, 85. Tests on completion.			
6	Changes in statutes	7.4 Testing, 8.4 Extension of time for completion, 13.7 Adjustments for changes in legislation, 13.8 Adjustments for changes in cost, 14.15 Currencies of payment.	16. Change in laws and regulations, 62. Price adjustments, 73. Extension of intended completion date, 75. Acceleration.	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011	FIDIC 1999/ PPPAA'S 2011

Common allocation of risk in building construction contract for the parties having an effect on building contractors under FIDIC 1999 and PPPAA's 2011. (Source; compiled by the researcher.)

Appendix E: SPEARMAN'S CORRELATION TABLE

Respondents	Risk	Spearman's rank correlation coefficient (r's) on probability of occurrence					
	Group	BC/GC 1	Correlation	BC/GC 2	Correlation	BC/GC 3	Correlation
BC/GC 1	A	1	-	0.827	Strong	0.781	Strong
	B	1	-	0.746	Strong	1.000	Strong
	C	1	-	0.942	Strong	0.822	Strong
	D	1	-	0.986	Strong	0.597	Strong
	E	1	-	0.988	Strong	0.835	Strong
	F	1	-	0.976	Strong	0.905	Strong
	G	1	-	0.855	Strong	0.924	Strong
BC/GC 2	A	0.827	Strong	1	-	0.579	Strong
	B	0.746	Strong	1	-	0.533	Strong
	C	0.942	Strong	1	-	0.874	Strong
	D	0.986	Strong	1	-	0.962	Strong
	E	0.988	Strong	1	-	0.982	Strong
	F	0.976	Strong	1	-	0.976	Strong
	G	0.855	Strong	1	-	0.865	Strong
BC/GC 3	A	0.781	Strong	0.579	Strong	1	-
	B	1.000	Strong	0.533	Strong	1	-
	C	0.822	Strong	0.874	Strong	1	-
	D	0.597	Strong	0.962	Strong	1	-
	E	0.835	Strong	0.982	Strong	1	-
	F	0.905	Strong	0.976	Strong	1	-
	G	0.924	Strong	0.865	Strong	1	-

Respondents	Risk	Spearman's rank correlation coefficient (r's) impact on time					
	Group	BC/GC 1	Correlation	BC/GC 2	Correlation	BC/GC 3	Correlation
BC/GC 1	A	1	-	0.929	Strong	0.643	Strong
	B	1	-	0.884	Strong	0.606	Strong
	C	1	-	0.748	Strong	0.489	Moderate
	D	1	-	0.933	Strong	0.409	Moderate
	E	1	-	0.963	Strong	0.806	Strong
	F	1	-	0.976	Strong	0.914	Strong
	G	1	-	0.961	Strong	0.549	Strong
BC/GC 2	A	0.929	Strong	1	-	0.549	Strong
	B	0.884	Strong	1	-	0.729	Strong
	C	0.748	Strong	1	-	0.247	Moderate
	D	0.933	Strong	1	-	0.509	Strong
	E	0.963	Strong	1	-	0.768	Strong
	F	0.976	Strong	1	-	0.970	Strong
	G	0.961	Strong	1	-	0.913	Strong
BC/GC 3	A	0.643	Strong	0.549	Strong	1	-
	B	0.606	Strong	0.729	Strong	1	-
	C	0.489	Moderate	0.247	Moderate	1	-
	D	0.409	Moderate	0.509	Strong	1	-
	E	0.806	Strong	0.768	Strong	1	-
	F	0.914	Strong	0.970	Strong	1	-
	G	0.549	Strong	0.913	Strong	1	-

Respondents	Risk	Spearman's rank correlation coefficient (r's) impact on cost					
	Group	BC/GC 1	Correlation	BC/GC 2	Correlation	BC/GC 3	Correlation
BC/GC 1	A	1	-	0.960	Strong	0.817	Strong
	B	1	-	0.567	Strong	0.900	Strong
	C	1	-	0.574	Strong	0.380	Moderate
	D	1	-	0.944	Strong	0.062	Weak
	E	1	-	0.922	Strong	0.449	Moderate
	F	1	-	0.881	Strong	0.390	Moderate
	G	1	-	0.903	Strong	-0.191	Weak
BC/GC 2	A	0.960	Strong	1	-	0.901	Strong
	B	0.567	Strong	1	-	0.000	Weak
	C	0.574	Strong	1	-	0.433	Moderate
	D	0.944	Strong	1	-	0.740	Strong
	E	0.922	Strong	1	-	0.789	Strong
	F	0.881	Strong	1	-	0.535	Strong
	G	0.903	Strong	1	-	0.156	Weak
BC/GC 3	A	0.817	Strong	0.901	Strong	1	-
	B	0.900	Strong	0.000	Weak	1	-
	C	0.380	Moderate	0.433	Moderate	1	-
	D	0.062	Weak	0.740	Strong	1	-
	E	0.449	Moderate	0.789	Strong	1	-
	F	0.390	Moderate	0.535	Strong	1	-
	G	-0.191	Weak	0.156	Weak	1	-

Respondents	Risk	Spearman's rank correlation coefficient (r's) impact on quality					
	Group	BC/GC 1	Correlation	BC/GC 2	Correlation	BC/GC 3	Correlation
BC/GC 1	A	1	-	0.815	Strong	0.790	Strong
	B	1	-	0.866	Strong	0.700	Strong
	C	1	-	0.946	Strong	0.463	Moderate
	D	1	-	0.457	Moderate	0.617	Strong
	E	1	-	0.766	Strong	0.237	Moderate
	F	1	-	0.816	Strong	0.457	Moderate
	G	1	-	0.903	Strong	-0.230	Moderate
BC/GC 2	A	0.815	Strong	1	-	0.513	Strong
	B	0.866	Strong	1	-	0.770	Strong
	C	0.946	Strong	1	-	0.407	Moderate
	D	0.457	Moderate	1	-	0.378	Moderate
	E	0.766	Strong	1	-	0.424	Moderate
	F	0.816	Strong	1	-	0.424	Moderate
	G	0.903	Strong	1	-	-0.312	Moderate
BC/GC 3	A	0.790	Strong	0.513	Strong	1	-
	B	0.700	Strong	0.770	Strong	1	-
	C	0.463	Moderate	0.407	Moderate	1	-
	D	0.617	Strong	0.378	Moderate	1	-
	E	0.237	Moderate	0.424	Moderate	1	-
	F	0.457	Moderate	0.424	Moderate	1	-
	G	-0.230	Moderate	-0.312	Moderate	1	-